# LONGSHOT MINE AND MILL

Colville National Forest
Stevens County, Washington

## SITE INSPECTION REPORT

November 18, 2005

Prepared For:
U.S. Forest Service, Region 6
10600 NE 51st Circle
Vancouver, Washington 98682

MSE
Millennium Science & Engineering, Inc.

# SITE INSPECTION REPORT

**Longshot Mine and Mill**
**Colville National Forest, Washington** **November 18, 2005**


Principal Author: Michael J. Puett, P.E.
Project Manager

Reviewed By: Michael L. May
Technical Reviewer


Prepared For: USDA Forest Service
Gifford Pinchot National Forest
10600 NE 51st Circle
Vancouver, WA 98682


Prepared by: Millennium Science and Engineering, Inc.
1605 North 13th Street
Boise, Idaho 83702
(208) 345-8292


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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| cfs | Cubic feet per second |
| $ft^2$ | Square feet |
| gpm | Gallon per minute |
| lbs | Pound |
| mg $CaCO_3$/L | Milligram calcium carbonate per liter |
| mg/kg | Milligram per kilogram |
| mg/L | Milligram per liter |
| $mi^2$ | Square mile |
| mV | Millivolt |
| $yd^3$ | Cubic yard |
| %R | Percent recovery |
| | |
| ABA | Acid Base Accounting |
| AGP | Acid Generating Potential |
| AMD | Acid mine drainage |
| ANP | Acid Neutralizing Potential |
| APA | Abbreviated Preliminary Assessment |
| | |
| bgs | Below ground surface |
| BIBI | Benthic Invertebrate Index of Biological Integrity |
| BLM | United States Bureau of Land Management |
| | |
| CDI | Chronic daily intake |
| CERCLA | Comprehensive Emergency Response, Compensation & Liability Act |
| CN | Cyanide |
| COI | Contaminant of interest |
| COPC | Contaminant of potential concern |
| CPEC | Contaminant of potential ecological concern |
| CTE | Central tendency exposure |
| | |
| DO | Dissolved oxygen |
| | |
| Ec | Electrical conductivity |
| Eco-SSL | Ecological Soil Screening Level |
| ECR | Excess cancer risk |
| EE/CA | Engineering Evaluation/Cost Analysis |
| EPA | United States Environmental Protection Agency |
| EPC | Exposure point concentration |
| EPT | Ephemeroptera, Plecoptera, and Trichoptera |
| ERA | Ecological risk assessment |
| | |
| FWS | U.S. Fish and Wildlife Service |
| | |
| GIS | Geographic information system |
| GPS | Global positioning system |
| | |
| HHRA | Human health risk assessment |

**ACRONYMS AND ABBREVIATIONS (Continued)**

| | |
|---|---|
| HI | Hazard index |
| HQ | Hazard quotient |
| IEUBK | Integrated Exposure Uptake Biokentic |
| LCS | Laboratory control sample |
| MCL | Maximum contaminant level |
| MDC | Maximum detected concentration |
| MS/MSD | Matrix spike/matrix spike duplicate |
| MSE | Millennium Science and Engineering, Inc. |
| MTCA | Model Toxics Control Act |
| NNP | Net neutralization potential |
| ORNL | Oak Ridge National Laboratory |
| PRG | Preliminary Remediation Goal |
| PRISM | Parameter Regressions on Independent Slopes Model |
| QA | Quality assurance |
| RAGS | Risk Assessment Guidance for Superfund |
| RfD | Reference dose |
| RMC | Risk Management Criteria |
| RME | Reasonable maximum exposure |
| RPD | Relative percent difference |
| SF | Slope factor |
| SI | Site Inspection |
| SLV | Screening level value |
| SOC | Species of concern |
| SVL | SVL Analytical Laboratory |
| T&E | Threatened and endangered |
| TALM | Target Analyte List Metals |
| TEL | Threshold effects level |
| TOC | Total organic carbon |
| TRV | Toxicity reference value |
| $UCL_{95}$ | 95 percent upper confidence limit |
| USFS | United States Forest Service |
| USGS | United States Geological Survey |
| WDOE | Washington Department of Ecology |
| WRCC | Western Regional Climate Center |
| XRF | X-Ray Fluorescence |

## EXECUTIVE SUMMARY

The Longshot Mine is an inactive lead-zinc mine and mill, located about 11 miles northeast of Colville, Washington on the Colville National Forest. Under contract to the USDA Forest Service (USFS), Millennium Science and Engineering, Inc. (MSE) completed a Site Inspection (SI) of the Longshot Mine site to (1) characterize site features and physical hazards, (2) assess potential risks to human and ecological receptors at the site from exposure to mine wastes, (3) estimate mine waste quantities, and (4) determine background soil concentrations. This report describes the SI field investigation activities and summarizes analytical results, mine waste volume estimates, a physical hazards assessment, and streamlined human health and ecological risk assessments.

Site features at the Longshot Mine include:

- Remnants of a mill and other wooden structures
- Two open adits and one open stope
- Two ponds
- An unprocessed ore bin
- Six waste rock piles
- Three tailings impoundments

A total of 50 samples were collected from the background soils, mine waste (tailings and waste rock), sediment, surface water, pore water, and benthic macroinvertebrates. Analytical results of the samples indicate elevated concentrations of several metals in the tailings and waste rock, particularly arsenic and lead. Metals concentrations in the sediment samples were significantly lower and only a few metals were detected in the surface water samples. Potential acid generation in the mine waste is very low, and there is no obvious evidence of contaminant migration from the site.

Streamlined human health and ecological risk assessments for the following pathways were completed to assess potential risks to human and ecological receptors at the site.

- **Groundwater Pathway:** The groundwater pathway is incomplete because there is only one well within a 1-mile radius and it is not hydraulically connected to the site.

- **Surface Water Pathway:** The surface water pathway is complete for human receptors but insignificant because of the low metals concentrations; however, the pathway is complete and significant for ecological receptors because of elevated metals concentrations in the sediments.

- **Soil Pathway:** The soil pathway is complete and significant for both human and ecological receptors because of elevated metals concentrations in the mine wastes.

- **Air Pathway:** The air pathway is complete for human receptors but insignificant because of extremely low risk levels.

Results of the streamlined human health risk assessment (HHRA) indicate risk from exposure to metals in mine wastes at the site. The most significant exposure pathway is ingestion of and dermal contact with the mine waste. Inhalation of particulates from the mine waste, and ingestion of and dermal contact with surface water contribute minimal risk and are insignificant pathways. Two human health contaminants of potential concern (COPCs) were identified: arsenic and lead. Arsenic poses carcinogenic risk only to the child receptor and only under the reasonable maximum exposure (RME) scenario. Lead risks were not quantified because of the lack of established toxicological data and the limitations of current lead exposure models. However, lead concentrations were compared to U.S. Environmental Protection Agency (EPA) human health screening criteria and U.S. Bureau of Land Management (BLM) risk management criteria (RMCs) to evaluate potential risks from exposure to lead at the Longshot Mine. Because the maximum detected lead concentration in the mine waste is more than 30 times the EPA human health screening level, there appears to be significant risk to both the adult and child receptors from exposure to lead at the site.

Results of the streamlined ecological risk assessment (ERA) indicate significant potential risk to ecological receptors at the site; however, the risks are at the individual level rather than the population level. While individual receptors may be exposed to metals in mine wastes at the site, their populations are unlikely to be significantly impacted because it is improbable that entire populations of receptors reside strictly within the bounds of the site. Several contaminants of potential ecological concern (CPECs) were identified, most notably aluminum, cadmium, lead and zinc. The highest risk ratios are in the mine waste, and there is limited risk to individual aquatic receptors from exposure to metals in sediment. There appears to be very limited ecological risk from exposure to surface water or pore water at the site.

There is no documented evidence of sensitive or threatened and endangered (T&E) species at the site and none were observed during the field investigation by MSE in June 2005. However, the Colville National Forest is listed as providing habitat for several T&E species, including the woodland caribou, grizzly bear, Canada lynx, gray wolf, and bald eagle. Although these animals may occasionally traverse the site, it is unlikely that their habitat would be limited to within the site boundaries.

Several significant physical hazards exist at the site, including two open adits, vertical stope, a vertical rock face surrounding the stope, unstable mill frame and several collapsed wooden structures, and wood and metal debris scattered throughout the site.

Based on the results of this SI and the streamlined HHRA, MSE recommends performing a streamlined Engineering Evaluation/Cost Analysis (EE/CA) to address physical hazards at the site and potential human health risks from exposure to lead concentrations in the mine waste.

# SITE INSPECTION DATA SUMMARY SHEET

Project Name: Longshot Mine and Mill Site Inspection
Project Location: Section 18, Township 36 North, Range 41 East of the Willamette Meridian; Stevens County, WA
Latitude: 48° 37' 18" Longitude: W 117° 41' 27" Nearest Surface Water Body: South Fork Mill Creek, approximately 1.5 miles from site
Area of Disturbance: Approximately 5 acres

## SUMMARY OF SITE CHARACTERIZATION ANALYTICAL RESULTS

| Medium | Volume/Rate of Discharge | Contaminant of Potential Concern[a] | Maximum Detected Concentration | Lowest Screening Criteria | Background Concentration[b] |
|---|---|---|---|---|---|
| Mine Waste | ~3,200 cubic yards | Silver | 176 mg/kg | 2 mg/kg – Eco | 3.4 mg/kg[c] |
| | | Aluminum | 32,700 mg/kg | 50 mg/kg – Eco | 27,117 mg/kg |
| | | Arsenic | 41 mg/kg | 1.6 mg/kg – HH | 5.9 mg/kg |
| | | Cadmium | 191 mg/kg | 4 mg/kg – Eco | 3.7 mg/kg |
| | | Chromium | 49.1 mg/kg | 0.4 mg/kg – Eco | 37.3 mg/kg |
| | | Copper | 158 mg/kg | 50 mg/kg – Eco | 22.4 mg/kg |
| | | Manganese | 2,170 mg/kg | 1,100 mg/kg – Eco | 1,083 mg/kg |
| | | Lead | 30,000 mg/kg | 40.5 mg/kg – Eco | 268 mg/kg |
| | | Antimony | 88.5 mg/kg | 5 mg/kg – Eco | Undetected |
| | | Vanadium | 135 mg/kg | 2 mg/kg – Eco | 30.8 mg/kg |
| | | Zinc | 39,100 mg/kg | 8.5 mg/kg - Eco | 651 mg/kg |
| Sediment | | Cadmium | 7.41 mg/kg | 0.6 mg/kg – Eco | 0.34 mg/kg |
| | | Copper | 26.2 mg/kg | 16 mg/kg – Eco | 10 mg/kg |
| | | Lead | 90.4 mg/kg | 31 mg/kg – Eco | 5.0 mg/kg |
| | | Zinc | 442 mg/kg | 110 mg/kg - Eco | 18 mg/kg |
| Surface Water | 6.7 gallons per minute discharge from lower adit | Barium | 0.015 mg/L | 0.004 mg/L - Eco | 0.012 mg/L |
| | | Zinc | 0.066 mg/L | 0.03 mg/L - Eco | Undetected |
| Pore Water | | Barium | 0.027mg/L | 0.004 mg/L - Eco | 0.027 mg/L |
| | | Manganese | 0.12 mg/L | 0.05 mg/L – HH | 0.12 mg/L |

Notes:
[a]Only significant contaminants with concentrations above background and greater than 1.5x screening criteria are reported in this table.
[b]Background concentrations for mine waste based on 95 percent upper confidence limits ($UCL_{95}$) for background soil samples. If the $UCL_{95}$ was above the maximum detected concentration (MDC), the MDC was used. Background concentrations for sediment, surface water, and pore water all based on a single background sample.
[c]Detected in only one background sample, all other samples were undetected.
mg/kg = Milligram per kilogram
mg/L = Milligram per liter
Eco = Ecological; HH = Human health

# 1.0 INTRODUCTION

Millennium Science and Engineering, Inc. (MSE) was contracted by the USDA Forest Service (USFS) to perform a Site Inspection (SI) of the Longshot Mine and Mill on the Colville National Forest. This report describes the SI field investigation activities and summarizes analytical results, mine waste volume estimates, a physical hazards assessment, and streamlined human health and ecological risk assessments. The SI was performed in general accordance with U.S. Environmental Protection Agency (EPA) guidelines and state and federal regulations.

## 1.1 Site Description

The Longshot Mine is an inactive lead-zinc mine and mill, located about 11 miles northeast of Colville, Washington in Stevens County. The site is located in the eastern half of Section 18, Township 36 North, Range 41 East of the Willamette Meridian (Figures 1 and 2). Site features include:

- Remnants of a mill and other wooden structures
- Two open adits and one open stope
- Two ponds
- An unprocessed ore bin
- Six waste rock piles
- Three tailings impoundments

Access to the site is via USFS Spur Road 150 from County Road 4954. The site is on a hillside adjacent to an unnamed ephemeral tributary to South Fork Mill Creek. The site is located near the top of a ridge at an elevation of about 3,600 feet. Ore from two adits was processed at the mill and tailings were deposited in a series of three impoundments in the ephemeral drainage. Unprocessed ore is piled in an ore bin at the mill. Water discharges from the lower adit and flows through a small settling pond before disappearing beneath debris surrounding the mill structure. There is a second, larger pond in the ephemeral drainage below the last tailings impoundment. There are six waste rock piles: three near the upper adit, and three near the lower adit and mill. There is a vertical stope near the upper adit that extends into the underground workings. There are several collapsed wooden buildings and piles of debris near the lower adit and along the road to the upper adit. A more detailed description of the site is provided in Section 2.1.

### *1.1.1 Climate*

Available climate data for the site was obtained from the Western Regional Climate Center (WRCC) website (2005). The nearest climate station is located in Colville, Washington (11 miles southwest of the site) at an elevation of 1,640 feet. Because the site is significantly higher in elevation at 3,640 feet, the Parameter-elevation Regressions on Independent Slopes Model (PRISM) was used to estimate climate parameters for the site. The model was developed by a meteorologist to predict climate parameters using point data and a digital elevation model (Daly 1996). The model is considered to be a valuable hydrologic forecasting tool and is particularly well-suited to mountainous regions. The PRISM model was used to estimate the following climate parameters for the Longshot Mine site:

- Total average precipitation is approximately 40 inches per year
- Mean minimum temperatures is approximately 12° F
- Mean maximum temperature is approximately 78° F
- Wet days total approximately 112

### *1.1.2 Regional Geology*

The Longshot Mine is located in the Intermontane Omineca physiographic area of northeastern Washington (Orr and Orr 1996). Characteristics of this area include deep and narrow valleys with rounded mountains up to 8,000 feet in elevation (Schuster and Teissere 2002).

During the Quaternary period, sheets of ice covered the Omineca belt, which created the topography for lakes throughout the region (Schuster and Teissere 2002). Volcanism during the Tertiary period shaped the geology of the regions through the deposition of debris into basins. The Omineca province was formed during the Jurassic period when the Intermontane and the North American superterrane collided (Orr and Orr 1996). As a result of this accretion, Paleozoic marine sediments were deposited over the Precambrian metasedimentary rocks (Schuster and Teissere 2002), and granitic intrusives distributed throughout the region (Orr and Orr 1996). The middle Cambrian Metaline Limestone exists through this province indicative of the historic ocean shelf conditions, covering the volcanic layers with fluvial and lacustrine sediments. The site is characterized as Tertiary to middle Proterozoic bedrock up to 300 feet deep. Bedrock is composed of conglomerate, sandstone, siltstone, shale, quartzite, dolomite, argillite, granite, and basalt. Primary ore minerals at the site include galena, sphalerite, tetrahedrite, and scheelite.

### *1.1.3 Hydrogeology*

Hydrogeologic information for the site was taken from the U.S. Geological Survey (USGS) report *"Water Resources of the Groundwater System in the Unconsolidated Deposits of the Colville River Watershed, Stevens County, Washington"* (Kahle *et al*. 2003). The site is located in a bedrock unit with low permeability. Bedrock at or near land surface provides numerous drinking water wells throughout the Colville River Watershed. However, according to Washington Department of Ecology's (WDOE) Water Resources Well Log website (http://apps.ecy.wa.gov/well logs), only one drinking water well is recorded within 1 mile of the site and its location is uncertain given conflicting information in the water well report. According to the section, township and range information, the well should be in Stevens County approximately 0.5 miles southwest of the site (see Figure 2); however, the location of the well is identified as Pend Oreille County. Nonetheless, if the well is present at the location shown on Figure 2, it is in a different drainage and should not be hydraulically connected to the site; therefore, groundwater at the site is not a complete exposure pathway.

Bedrock structures typically exhibit low permeability, unless the unit has been fractured through folds, faulting, drilling, or mining practices. Fractures in bedrock and the underground mine workings may provide a conduit for flow from the lower adit. According to the USGS, hydraulic conductivity through fractured bedrock is about 1.3 feet per day in the Colville River Watershed.

South Fork Mill Creek is in the Colville Valley confining unit, which consists of extensive glaciolacustrine silt and clay with low permeability. This unit is overlain with stream alluvium in some areas and estimated to be 150 feet thick, with a typical hydraulic conductivity of 110 feet per day (Kahle *et al.* 2003).

Groundwater storage and discharge to streams in the major drainages within the Colville River Watershed were estimated by the USGS using the PULSE computer simulation model. The model estimated that there is, on average, about 5 inches of groundwater recharge each year (Kahle *et al.* 2003).

### *1.1.4 Hydrology*

The site is located near the top of a small drainage that ranges in elevation from 2,920 to 3,720 feet. Snow melt and precipitation in the drainage forms an unnamed ephemeral tributary to South Fork Mill Creek, which is a third-order stream that flows into Mill Creek, the third largest tributary to the Colville River (Kahle *et al.* 2003). During the field investigation in June 2005, the ephemeral tributary was dry, except for isolated seeps that only flowed short distances before infiltrating.

South Fork Mill Creek is several hundred feet wide where the ephemeral tributary enters, and consists of unconfined meadow pool habitat with several beaver dams and widely dispersed flow. The upstream valley also has several beaver dams and widely dispersed flow. About ¼ mile downstream, the creek enters a narrow canyon and flows converge into a well-defined stream channel. Bert Wasson, hydrologist for the Colville National Forest, confirmed that the beaver dams have been established for over 30 years; and that there are multiple land uses upstream including livestock grazing, timber, mining, and road/railroad. All of these influences likely contribute sediment to South Fork Mill Creek that is then trapped behind the beaver dams.

Snow melt and run off are the primary contributor to stream flows in the area because of higher elevations in the surrounding hills. Stream discharge data were retrieved from the USGS gage station 12408500 on Mill Creek (USGS 2005). The gaging station is located about 2 miles downstream of the confluence of the ephemeral tributary from the site and South Fork Mill Creek. Annual mean stream flow at the gage ranges from 17.7 cubic feet per second (cfs) in 1944, to 81.7 cfs in 1961, and peak flows range from 50 to 700 cfs. Flooding rarely occurs at the confluence of Mill Creek and the Colville River, but occurs infrequently as a result of extreme rain on snow events.

### *1.1.5 Wetlands*

Wetlands information was retrieved from the U.S. Fish and Wildlife Service (FWS) National Wetlands Inventory through the wetland online mapper at http://wetlandsfws.er.usgs.gov (2005a). The FWS used high altitude aerial photography to delineate wetland areas, and the wetlands were identified by three indicators: (1) visible hydrology, (2) vegetation, and (3) geology (Cowardin *et al.* 1979). According to the FWS, the only wetlands near the site are located along South Fork Mill Creek. Freshwater emergent and freshwater forested/shrub wetlands occur upstream and downstream of where the ephemeral tributary from the site enters South Fork Mill Creek. The wetland areas are predominantly upstream of the confluence, where the valley is less confined. The wetlands were described as follows:

- At the confluence of the ephemeral tributary from the site and South Fork Mill Creek, the wetlands are Palustrine, emergent, persistent, and temporarily flooded.
- Upstream (~0.5 miles) of the confluence, the wetlands are Palustrine, scrub-scrub, broad-leafed deciduous, and seasonally flooded.
- Downstream (~1.0 miles) of the confluence, the wetlands are Palustrine, forested, and artificially flooded.

### *1.1.6 Terrestrial Habitat*

The site is located in the Colville National Forest and within the Okanogan Highlands Ecoregion. Terrestrial habitats in vicinity of the site include steep woodland hillsides, meadows, riparian zones, and wetland areas. The dominant vegetation types on the hillsides are *Thuja plicata* (interior western hemlock) and *Tsuga heterophylla* (interior red cedar). *Abies lasiocarpa* (subalpine fir) occurs in higher elevations, and *Pinus ponderosa* (Ponderosa pine) and *Arceuthobium douglasii* (Douglas fir) at lower elevations. The hillsides were characterized by a fairly dense overstory and understory. Dominant understory vegetation consists of *carex* spp., forbs, *salix* spp., *Equisetum* spp. and fern species (Schuster and Teissere 2002).

#### *1.1.7 Threatened and Endangered Species*

Information regarding threatened and endangered (T&E) species and species of concern (SOC) for wildlife and plant species occurring in Eastern Washington was obtained from the FWS Upper Columbia River Field Office (2005b), and Colville National Forest Office (2004). Animal and plant species listed as T&E within the Colville National Forest are listed in Attachment B to the streamlined ecological risk assessment (ERA). There are no T&E species documented as inhabiting the site and none were observed during the field investigation conducted by MSE in June 2005.

Spatial data from the Colville National Forest available online at http://www.fs.fed.us/r6/data-library/gis/colville/index.html was used to examine further the presence of T&E species at the Longshot Mine. Using the geographic information system (GIS) tool ArcMap, the site location was overlain with shape files for each of the listed species. Based on the shape files, grizzly bear and woodland caribou habitat are not present at the site. The Canada Lynx habitat boundary is near the site and the species may be present, or occasionally traverse the site. Data for the bald eagle, gray wolf, and bull trout habitats were not available. However, according to the USFS Colville National Forest hydrologist, the bull trout does not occur in the South Fork of Mill Creek, (Personal Communication, B. Wasson 2005).

### 1.2 Operational History

Information regarding the operational history of the Longshot Mine is very limited. The available information is summarized below:

- 1942 to 1952: Three unpatented claims owned by Robert Ferguson and George Watson of Spokane, Washington (Huntting 1956). The site was leased to Pioneer Mining Co. from 1951 to 1956.
- Development of the site included a 600-foot long crosscut adit with drifts, raises, and stopes (Moen 1976).
- The mill was constructed in 1951 and was capable of processing 40 tons of ore per day (Huntting 1956).
- Ore produced from the Longshot Mine from 1951 to 1955 included 246 tons of total ore composed of 16,330 pounds (lbs) of lead; 20,581 lbs of zinc; 5,094 ounces of silver; and 3 ounces of gold (Moen 1976).
- According to the U.S. Bureau of Mines (1993), the volume of ore processed between 1951 and 1955 was 1,750 tons.

### 1.3 Previous Investigations

An Abbreviated Preliminary Assessment (APA) of the site was completed by the USFS (2003) in September 2003. Two soil samples, one from an ore bin at the mill and one from a tailings impoundment, were analyzed for contaminants of interest (COIs) using a portable X-ray fluorescence (XRF) analyzer.

Lead was the only COI detected at concentrations exceeding EPA Region IX Industrial Soil Preliminary Remediation Goals (PRGs) (EPA 2004a). However, the detection limit for some COIs may have been greater than the PRG, resulting in false negatives. Based on the observed lead concentrations, the APA recommended an SI be completed.

### 1.4 Purpose and Objectives

The SI is a component of the Superfund Accelerated Cleanup Model, devised by EPA to meet the requirements of the Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA). The Longshot SI is intended to provide sufficient and appropriate information for: (1) assessing potential risks to human health and the environment, and (2) developing and evaluating potential removal action alternatives. The primary objectives of the Longshot SI were to:

- Determine if a release has occurred;
- Estimate the volume and extent of an existing or potential release;
- Evaluate existing or potential impacts to terrestrial and aquatic habitats;
- Evaluate existing or potential risk to human and ecological receptors and, if necessary, establish appropriate risk-based, site-specific, clean up levels; and
- Estimate 95 percent Upper Confidence Levels ($UCL_{95}$) for soil background concentrations.

## 2.0 FIELD INVESTIGATION

MSE conducted a field investigation of the Longshot Mine site June 21-23, 2005. Field investigation activities included: (1) a site reconnaissance to identify, inventory, and document the location and condition of mine waste sources and physical hazards; (2) using a portable XRF analyzer to identify and screen mine waste areas; (3) completing a limited topographical survey of the site; (4) completing hand borings in the tailings impoundments to determine depths and assist in estimating material quantities; and (5) collecting mine waste, background soil, surface water, pore water, sediment, and benthic macroinvertebrate samples. The following sections describe the field investigation activities.

### 2.1 Site Reconnaissance and Physical Hazards Survey

Field staff inspected the site and inventoried mine-related features, including structures and physical hazards, adits, stopes, waste rock piles, tailings impoundments, ponds, and other potential hazards or sources of contamination. Site features observed during the field investigation are discussed in this section and shown on Figure 3.

The access road to the site (USFS Spur Road 150) leads to a turnaround at the mill and lower adit. The road continues to the upper adit but access is blocked by vegetation and large rocks. The upper adit is about 700 feet upslope of the lower adit. Both adits are open and unframed, and there are visible trails leading into them. The upper adit was dry and there was no visible sign of historic or episodic flows from the adit. Above the upper adit, at the base of a large exposed rock face, a stope extends vertically about 50 feet down into the adit. Rock that appears to be a mixture of road cut and waste rock is piled outside the mouth of the adit and along a small road leading from the upper adit to the stope. Waste rock piles WR4, WR5, and WR6 are located near the upper adit.

The lower adit appears to be where most of the mining activities occurred. The mill is directly across the access road and there are three waste rock piles (WR1, WR2, WR3) and remnants of several wooden structures and piles of wood debris outside the lower adit. A wet, marshy area leads to the adit, and water flows from the adit at approximately 6.7 gallons per minute (gpm). The water flows along the access road and through a small settling pond (PD1) before crossing the road just above the mill and disappearing under the mill debris. It is unknown whether the adit flows year-round.

The mill was constructed along a hillside next to the access road that slopes down into the ephemeral drainage. The mill frame is partially collapsed and is structurally unstable. Unprocessed ore is piled near the top of the mill and in an ore bin at the bottom of the mill structure. Extensive wood and metal debris covers the hillside immediately below the mill and is scattered along the bottom of the ephemeral drainage. Below the mill is an unnamed ephemeral tributary to South Fork Mill Creek. There is little evidence of concentrated flow in the ephemeral tributary upstream of the site and the channel was dry during the field investigation in June 2005.

Tailings from the mill had been placed in the ephemeral drainage in a series of relatively small tailings impoundments. The impoundments are thin (0 to about 5.5 feet), heavily vegetated, and not well defined in areas. The impoundments were dry during the field investigation but subsurface flow was evidenced by isolated, wet boggy areas. Also, hand borings in the tailings impoundments indicated saturation at about 3 to 4 feet below ground surface (bgs). The first impoundment (TA1) is about 200 feet from the mill and covers about 1,700 square feet ($ft^2$). The second tailings impoundment (TA2) is immediately downstream of the first and covers about 5,000 $ft^2$. A third tailings impoundment (TA3) is located along the hillside near the second impoundment and covers about 4,200 $ft^2$. It differs from the first two impoundments in that it appears to consist of tailings that were excavated from one of the impoundments and dumped in place. A small earthen embankment separates TA1 and TA2, and a larger earthen embankment separates the TA2 from a wet marshy area that leads to a large pond (PD2). The pond is approximately 50 feet in diameter and up to 8 feet deep. There appears to be some sort of structural foundation in the pond bottom and there is a significant amount of wooden debris in the pond. Below the pond embankment is a wet, marshy area that extends about 100 feet to a road crossing. The road crossing is slightly elevated above the drainage (about 2 feet) and there is a 12-inch diameter culvert under the road. However, during the field investigation the culvert was dry and all flow appeared to infiltrate before reaching the road.

Immediately downstream of the road crossing, the drainage widens and the channel appears to infiltrate and/or convert to sheet flow because there was no evidence of a stream channel or concentrated flows. Approximately 600 feet down the drainage, below the confluence with another dry drainage, a small stretch of flowing stream was encountered. The flow emanated from a seep and flowed for approximately 100 feet at 15 gpm before infiltrating and disappearing. The ephemeral drainage continues for approximately 1 mile where it combines with other drainages and crosses under County Road 4954 through an 18-inch culvert to South Fork Mill Creek. During the field investigation, the ephemeral drainage was dry but there was an active spring at the mouth of the adjacent drainage and water was flowing through the culvert at about 100 gpm. The channel continues for about 200 feet past the culvert before dispersing in a wide, marshy area leading to South Fork Mill Creek. At the confluence with the ephemeral tributary from the site, South Fork Mill Creek is several hundred feet wide and consists of unconfined meadow pool habitat with several beaver dams and widely dispersed flow. The point of confluence of the two channels is not well defined and the flows merge over a large marshy area.

## 2.2 XRF Screening

A portable Niton 700 XRF analyzer loaned from the USFS was used to screen for COIs and assist in identifying waste rock piles and delineating the extent of tailings impoundments. Background readings were also taken to assist in assessing background concentrations. The XRF analyzer was calibrated using the standard default calibration standards. A total of 21 readings were taken with the XRF analyzer and the results are summarized in Table 1.

The XRF analyzer detected primarily four COIs at the site: arsenic, lead, iron and zinc. There were also scattered detections of chromium, manganese, molybdenum and nickel. Of the 21 readings, 6 were taken from areas representative of background conditions for the site based on visual observations. The remaining 15 readings were taken from the ore bin, waste rock piles, tailings impoundments, and other disturbed areas. The results are summarized below:

- Background concentrations of lead and zinc ranged from undetected to 39.4 milligram per kilogram (mg/kg), and 114 to 488 mg/kg, respectively;
- The ore bin (reading X2) had the highest concentrations of arsenic (304 mg/kg), lead (9,040 mg/kg), and zinc (2,270 mg/kg); and
- In the remaining samples, arsenic concentrations ranged from undetected to 74.6 mg/kg, lead concentrations ranged from undetected to 2,140 mg/kg, and zinc concentrations ranged from 62.6 to 1,910 mg/kg.

## 2.3 Site Mapping

RFK Surveying from Colville was contracted to perform a limited topographical survey of the site. The objectives were to collect sufficient topographic data points to: (1) generate a 1-foot contour map of the site, (2) delineate waste areas, (3) assist in estimating mine waste quantities, and (4) identify key site features and hazards. The survey did not include locating or surveying property boundaries. No benchmark could be found on site, and the dense vegetative canopy cover prevented using a global positioning system (GPS) instrument, so control was established using existing benchmarks on County Road 4954 and establishing temporary benchmarks along USFS Spur Road 150 to the site. The approximate boundaries of the tailings impoundments and waste rock piles were flagged to assist the surveyors in delineating the waste areas.

## 2.4 Mine Waste Volume Estimation

The topography and dimensions of each waste rock pile and tailings impoundment were surveyed to assist in estimating mine waste volumes. A portable 5-foot hand auger was used to bore holes in the three tailings impoundments to measure the depth of tailings. The hand auger could not be used in the waste rock piles because of the coarse rocky material. A total of 27 borings were made consisting of multiple borings in each impoundment. The boring depth was limited to 5 feet because of the auger length. The tailings-soil interface was easily identifiable, and the depths of tailings ranged from 0.5 to more than 5.0 feet. Four borings did not reach the tailings-soil interface; however, the depth in those borings was estimated to be 5.5 feet based on the surrounding topography. The average tailings depth was estimated to be about 2.9 feet in TA1, 2.6 feet in TA2, and 1.7 feet in TA3. In all three tailings impoundments, saturated tailings were encountered at depths ranging from 1.5 to 3 feet.

The physical dimensions and estimated volume of each waste rock pile and tailings impoundment are summarized in Table 2. The waste rock volumes are summarized below and are estimated based on comparing the topographic survey to the approximated pre-mining topography:

- The total estimated volume of tailings and waste rock is 942 cubic yards ($yd^3$) and 2,187 $yd^3$, respectively.
- The combined total estimated volume of mine waste at the site is 3,129 $yd^3$.

The waste rock piles and tailings impoundments were also inspected for evidence of flooding and erosion. All waste rock piles are located on a hillside above the ephemeral drainage and are not subject to flooding or erosion from stream flows. The tailings impoundments are located directly in the ephemeral drainage and may be subject to periodic flooding. However, the site is near the top of the drainage and there is no visual evidence of erosion on the tailings impoundments or transport of tailings from the site.

## 2.5 Sample Collection

Samples of mine waste, background soil, surface water, sediment, pore water, and benthic macroinvertebrates were collected from the locations shown on Figure 3, and summarized in Table 3. Mine waste characterization samples were collected from the tailings impoundments, waste rock piles, and ore bin. Surface water and sediment samples were collected from the adit discharge, two ponds, seeps along the ephemeral tributary, and South Fork Mill Creek. Pore water and benthic macroinvertebrate samples were collected from South Fork Mill Creek. Background soil samples were collected from undisturbed areas around the site. Because of the lack of upstream flow in the ephemeral drainage, background surface water and sediment sampling were limited to a single sample from a seep in an adjacent drainage near the site (Figure 2).

The sampling methods and procedures used for each media are described in the following sections.

### *2.5.1 Background Soil*

Background soil samples were collected from five areas (BG1 through BG5) near the mine that did not appear to have been disturbed by mining or other activities. The selected areas are expected to be representative of background conditions for the site. One grab sample was collected from each location at a depth of 6 to 12 inches utilizing disposable plastic hand trowels. One composite sample (BS-BG-C-01) also was collected and consisted of five subsamples, one from each grab sample location. The background soil sample locations are shown on Figure 3.

### *2.5.2 Mine Waste*

A total of 15 mine waste samples were collected from the tailing impoundments, waste rock piles, and unprocessed ore bin. Two grab samples (MW-OB1-G-01 and 02) were collected from the unprocessed ore bin and grab samples were collected from each of six waste rock piles (WR1 through WR6) and three tailings impoundments (TA1, TA2, and TA3). Two composite waste rock samples (MW-WR1-2-C, MW-WR5-6-C) and two composite tailings samples (MW-TA1-C, MW-TA2-C) also were collected. The composite samples each consisted of four to eleven subsamples. The samples were all collected from depths ranging from 6 to 12 inches bgs using disposable plastic hand trowels and spoons. A duplicate tailings sample (MW-TA1-G-02) was collected from TA1. The mine waste sample locations are shown on Figure 3.

### *2.5.3 Surface Water*

Surface water sampling included collecting grab samples, measuring stream flows, and measuring field parameters. A total of 10 surface water samples were collected from the adit discharge, ponds, ephemeral tributary seeps, South Fork Mill Creek, and one background seep. A sample (SW-AD1-01) of the adit discharge was collected at the mouth of the adit. One sample (SW-PD1) was collected from the small settling pond, and two samples were collected from the large pond, one from the northwest corner (SW-PD2-01), and one from the southeast corner (SW-PD2-02). Samples were collected in the ephemeral tributary from a seep just below the pond embankment (SW-ET3), and another seep approximately 600 feet further downstream (SW-ET2), shown on Figure 2. This location is also downstream of a confluence with a drainage that comes from an area above the site and is presumably unimpacted by the Longshot mining operations. A background sample (SW-BG1), also shown on Figure 2, was collected from a small seep in that drainage, approximately 400 feet upstream of SW-ET2.

The ephemeral tributary was dry just upstream of the confluence with South Fork Mill Creek; however, several drainages converge at the County Road 4954 crossing. A large spring was emanating from one of the drainages and a small pool had formed upstream of the culvert where the drainages converge. When there is flow in the ephemeral tributary, it would flow through this pool before entering the culvert. Therefore, a sample (SW-ET4) was collected from the pool. Two samples were collected from South Fork Mill Creek: upstream (SW-MC1), and downstream (SW-MC2) of the confluence with the ephemeral tributary.

Samples requiring dissolved analyses were filtered in the field using disposable Tygon® tubing, a peristaltic pump, and disposable 0.45-micron filters (filter area >600 square centimeters). New filters and tubing were used for each sample.

Field parameters were measured during sample collection and are summarized in Table 4. Stream flows were measured at the adit discharge and each seep and stream sample location using a portable Parshall flume or timed volumetric method, and are also summarized in Table 4. Stream flows were not measured on South Fork Mill Creek because of beaver ponds and the lack of concentrated stream flow.

### *2.5.4 Pore Water*

A total of two pore water samples were collected from South Fork Mill Creek at the surface water sample locations upstream (PW-MC1) and downstream (PW-MC2) of the ephemeral tributary. The pore water samples were collected immediately following collection of the surface water sample at each location. Pore water samples were not collected from the ephemeral tributary because of the lack of scientific reference data for benthic communities in ephemeral stream habitats and the absence of viable fish habitat.

The pore water samples were collected from the pore space in stream gravels in pool habitats where the substrate exceeded 6 inches depth. The samples were collected using a 27-inch stainless-steel pore water sampler. The sampler was inserted to a depth of about 6 inches and a pore water sample was extracted using Tygon® tubing and a peristaltic pump. New tubing and a new sampler were used at each sample location.

### *2.5.5 Sediment*

A total of 10 sediment samples were collected from the surface water sample locations. The stream sediment samples were collected from 0 to 2 inches below the streambed and composited from two subsamples, one from pool and one from riffle habitat. Sediment samples from South Fork Mill Creek were collected in coordination with the surface water and pore water samples. Sediment sample locations were located immediately upstream (SD-MC1) and downstream (SD-MC2) of the confluence with the ephemeral tributary. Composite samples were collected from each pond (SD-PD1, SD-PD2-1, and SD-PD2-2) and the adit discharge (SD-AD1), and consisted of three subsamples from 0 to 6 inches below the bottom surface.

Gravel and bits of vegetation were removed from the samples in the field and the lab was instructed to screen the sediment samples and discard material greater than 2 millimeters in diameter to focus the analysis on the finer material.

#### *2.5.6 Aquatic Survey*

An aquatic survey was completed to assess the potential impacts of the Longshot Mine on the instream habitat, benthic macroinvertebrate community, and the presence of fish species. Because of the limited scientific reference data for ephemeral stream habitats, the aquatic survey focused on South Fork Mill Creek near the confluence with the ephemeral tributary from the site. Two stream reaches, each approximately 100 meters in length, were established on South Fork Mill Creek immediately upstream and downstream of the confluence. An attempt was made to include both riffle and pool habitat within each reach. Physical habitat quality was quantified for each reach using EPA's *"Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers – Habitat Assessment Field Data Sheets"* (Barbour *et al.*1999), and *"Benthic Macroinvertebrate Biological Monitoring Protocols for Rivers and Streams"* (Plotnikoff and Wiseman 2001).

The presence of fish was documented by visual observations, and quantitative and qualitative data on water chemistry and physical habitat were collected. Water chemistry data were collected using a multi-parameter meter and included temperature, electrical conductivity (EC), dissolved oxygen (DO), pH, and turbidity. Turbidity was also measured in the field using a pocket turbidimeter.

#### *2.5.7 Benthic Macroinvertebrates*

Benthic macroinvertebrate samples were collected from the aquatic survey reaches on South Fork Mill Creek. Samples were collected from both the upstream and downstream reaches. Two composite samples were collected at from each reach, one from pool habitat and one from riffle habitat. Each composite sample consisted of three subsamples from different pool or riffle habitats within the stream reach. Collection of macroinvertebrate samples from specific pool habitats is necessitated by the potential of tails mobilizing into the streams and settling in areas of slower moving water. The samples were collected using a D-ring kick net. Sampling techniques were in accordance with the *"Benthic Macroinvertebrate Biological Monitoring* field with 85 percent ethanol and shipped to Aquatic Biology Associates, Inc. for processing.

## 3.0 PHYSICAL HAZARD ASSESSMENT

Several physical hazards were identified at the Longshot Mine, including:

- Two open adits and an open vertical stop
- A partially collapsed, structurally unstable, wooden mill frame
- Several piles of wood and other debris
- Large pond with wood debris

The following sections describe each hazard.

### 3.1 Open Adits and Stope

The open adits are easily accessible and have visible trails leading into the openings. The openings appear to be unsupported and constructed in competent rock. However, there is still risk of collapse or subsidence of the underground workings. The lower adit is located near the main road at the turnaround, along the southwest-facing hillside above the mill. The adit opening is approximately 6 feet in diameter. Water discharges from the adit and forms a small marshy area that extends to the access road. The surrounding area is densely vegetated with limited evidence of erosion or sloughing.

An overgrown road leads from the turnaround to the upper adit, located about 700 feet uphill from the lower adit. The upper adit opening is approximately 7 to 8 feet in diameter. The adit is deeply cut into the hillside and the surrounding area is densely vegetated with limited evidence of erosion or sloughing. The overgrown road continues past the upper adit to a vertical stope, located approximately 200 feet uphill from the upper adit. The vertical opening is about 8 feet in diameter and drops approximately 50 feet into the adit tunnel. An exposed vertical rock face about 30 feet high surrounds one side of the stope and there are scattered remains of a protective wooden fence around the opening. The open stope and vertical rock face pose significant fall hazards.

These unsecured mine openings present a significant physical hazard at the Longshot Mine site. The underground workings present an attractive nuisance to the public as evidenced by the trails leading into both adits. The workings may contain explosive gases or oxygen deficient atmospheres, which can result in injury or death for anyone venturing into the tunnels. There is also a constant danger of collapse or subsidence of the tunnels. The adits may also house bats, bears, mountain lions, rattlesnakes, and other potentially dangerous wildlife.

### 3.2 Collapsed Mill and Debris

A large, partially collapsed, wooden mill structure is located about 200 feet from the lower adit, across the access road. The mill frame is structurally unstable and poses a significant physical hazard. There is also a large quantity of wood and other debris scattered around the mill and extending down the hillside below the mill into the ephemeral drainage.

Four collapsed wooden structures and several piles of wood and metal debris were observed along the road leading from the lower adit to the upper adit. The wooden structures may contain residual explosives or other hazardous materials or chemicals commonly associated with mining operations. The wood debris is full of nails and sharp metal that also present a significant physical hazard. The structures and debris piles also may provide habitat for rattlesnakes and other potentially dangerous wildlife.

## 4.0 ANALYTICAL RESULTS

Solid and aqueous samples were submitted to SVL Analytical (SVL) in Kellogg, Idaho and the macroinvertebrate samples were submitted to Aquatic Biology Associates, Inc. in Corvallis, Oregon. Table 5 summarizes the samples and corresponding laboratory analyses. An iterative process was used to establish the list of COIs to be analyzed for. Because the ore and adit discharge were expected to have the highest contaminant concentrations, these samples were first analyzed for all 23 metals on the Target Analyte List plus cyanide (TALM+CN). The TALM consist of aluminum, antimony, arsenic, barium, beryllium, calcium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium and zinc. In the remaining samples, beryllium, selenium, and thallium were excluded from the metals analysis because they were not detected in the ore or adit discharge samples. Because mercury and cyanide have short holding times, they were determined in all samples. Paste pH also was measured on all solids samples and selected grab samples were analyzed for acid–base accounting (ABA). Sediment samples were also analyzed for total organic carbon (TOC) and total carbon content.

Analysis of aqueous samples included hardness and its associated metals for the purpose of comparing toxic metals concentrations with hardness–dependent water quality criteria. Sulfate also was determined as a tracer for evidence of acid generation. Both filtered and unfiltered samples were collected depending on the screening criteria. Filtered samples were collected for analysis of dissolved metals, hardness, total selenium, and total chromium; unfiltered samples were collected for analysis of total arsenic, mercury, cyanide, and sulfate. Arsenic and chromium speciation was determined in the laboratory for two filtered samples from the adit discharge (SW-AD1) and large pond (SW-PD2).

## 4.1 Background Soil

Analytical results of the background soil samples are presented in Table 6. The $UCL_{95}$ were calculated using EPA's PROUCL statistical analysis program. The program computes UCLs for each data set using several methods and recommends one based on the data distribution. However, data sets with fewer than 10 data samples can provide statistically unreliable estimates of the true average and the estimated $UCL_{95}$ may occasionally exceed the MDC. In those instances, the MDC was used in place of the $UCL_{95}$. Neither mercury nor antimony was detected in the background soil samples; silver was only detected in one sample. Several COIs in the background soil samples exceeded human health and/or ecological screening criteria as summarized below:

- The arsenic $UCL_{95}$ exceeded the EPA Region IX Industrial Soil PRG (1.6 mg/kg).
- The $UCL_{95}$ for both cadmium and chromium exceeded WDOE's Model Toxics Control Act (MTCA) Method A Industrial Soil Cleanup Levels; MTCA has not established a soil cleanup level for arsenic.
- The single detected silver concentration and $UCL_{95}$ for aluminum, barium, nickel, lead, vanadium, and zinc all exceeded WDOE's MTCA Ecological Indicator Soil Concentrations for Protection of Terrestrial Plants and Animals. All but one of these exceedances were for protection of plant life; the barium exceedance was for protection of wildlife.
- The $UCL_{95}$ for chromium and zinc both exceeded EPA Ecological Soil Screening Levels (Eco-SSLs).
- The single detected silver concentration and $UCL_{95}$ for chromium, nickel, lead, vanadium, and zinc exceeded Oak Ridge National Laboratory (ORNL) Soil PRGs for Ecological Endpoints.

## 4.2 Mine Waste

Analytical results of the mine waste samples are presented in Table 7. Beryllium, selenium, and thallium were not detected in the unprocessed ore and two initial tailings samples and; therefore, were removed from analyses for the subsequent mine waste, background soil, and sediment samples. Based on analytical results and sample physical descriptions, one sediment sample, SD-ET3-C-01, was reclassified as a tailings sample. Cyanide was detected in only one sample (MW-TA2-C-01) at 1.42 mg/kg. Most COI concentrations were elevated above background levels when compared to background soil $UCL_{95}$

and several samples exceeded both human health and ecological screening criteria. The most significant exceedances are summarized below:

- Lead concentrations exceeded the EPA Region IX Industrial Soil PRG (800 mg/kg) in 12 of 16 samples and ranged from 17 to 30,000 mg/kg. Lead concentrations also exceeded WDOE's MTCA Method A Industrial Soil Cleanup Level (1,000 mg/kg) in 11 of 16 samples. However, concentrations in only three samples were above 4,000 mg/kg.
- Arsenic concentrations exceeded the EPA Region IX Industrial Soil PRG (1.6 mg/kg) in all 16 samples and ranged from 3.5 to 41.0 mg/kg.
- Cadmium, chromium, and lead concentrations exceeded WDOE MTCA Method A Industrial Soil Cleanup Levels in most samples.
- Nearly all metals exceeded one or more WDOE and EPA ecological screening criteria.

### 4.3 Acid Base Accounting

A common concern at mine sites is the potential for generation of Acid Mine Drainage (AMD). The oxidation of sulfur-bearing minerals, especially pyrites, can result in a release of acids and dissolved metals to receiving waters. Once the process has started, an iron cycle is established, with a net production of hydrogen ions. Ferrous iron is oxidized slowly by microbes to ferric iron, which rapidly regenerates ferrous iron. Any ferric iron that precipitates out as amorphous "ferric hydroxide" forms a reservoir of available ferric ions. These enable the cycle to continue, even after pyrite is no longer available (Stumm and Morgan 1981). Factors affecting the potential for soil or waste rock to generate acid include the amount of sulfur-containing minerals present, amount of neutralizing minerals present, and composition and physical state of acid neutralizing minerals present.

The rate of acid generation is dependent upon the following factors:

- Types of sulfide minerals present and their crystal forms
- Types of carbonate and other neutralizing minerals present
- Waste particle size and surface area
- Presence of mineral grains and their surface areas
- Available water and oxygen
- Appropriate bacteria populations

Static testing, commonly referred to as ABA, predicts the potential for acid to be generated, based on the sulfur and carbonate content of the mineral (EPA 1994); however, for actual AMD to occur, the other conditions noted above must also be present. In ABA, a sample's Acid Generating Potential (AGP) is calculated from its pyritic sulfur (*i.e.,* sulfide) content and the Acid Neutralization Potential (ANP) is measured from its ability to react with acid. The result of the test is a figure of merit known as the Net Neutralization Potential (NNP). These values are reported in tons of calcium carbonate ($CaCO_3$) per 1,000 tons of soil. If the NNP is negative, there is a risk of acid generation. Values of NNP less than -20 indicate a material is likely to generate acid, and values greater than +20 indicate the material is unlikely to generate acid. Values between -20 and +20 fall into a zone of uncertainty, and kinetic testing is required to predict acid generation potential. Alternatively, the result can be evaluated in terms of the ratio ANP/AGP. Ratios greater than 3 represent a low risk, and ratios less than 1 represent a high risk of acid generation. Ratios between 1 and 3 fall into a zone of uncertainty. It should be noted that the accuracy of ABA can be adversely affected by the presence of acid-producing sulfate minerals, iron or magnesium carbonates, or metals which form hydroxide precipitates.

To estimate the potential for acid generation at the Longshot Mine, ABA tests were conducted on: (1) one background soil sample composited from the five grab samples, (2) two unprocessed ore grab samples, (3) two waste rock composite samples (from WR1 and WR2, and WR5 and WR6), and (4) two tailings composite samples (from TA1 and TA2). The ABA results are presented in Table 8 and summarized below:

- The NNP value for the background soil sample was 10.8, which is in the zone of uncertainty. The ANP/AGP ratio was 18 indicating a low risk of acid generation. Soil pH was neutral and ranged from 6.78 to 7.53.
- NNP values for the mine waste samples ranged from 30.6 to 932, and the ANP/AGP ratios ranged from 21 to 3,107 indicating a very low risk of acid generation. Mine waste pH was slightly alkaline and ranged from 7.53 to 8.37; total sulfur in all samples was less than 1 percent.
- The ABA results indicate a very low potential for acid generation in the background soils or mine waste.

## 4.4 Sediment

Analytical results of the sediment samples are presented in Table 9. Sediment sample SD-ET3-C-01 was determined to actually be a tailings sample based on COI concentrations and the physical description. Therefore, this sample was grouped with the mine waste samples discussed in the previous section. Only one background sediment sample was collected (SD-BG1-C-01). For most COIs, concentrations in the background sample were lower than the average concentration in the other samples; the exceptions were sodium, potassium, magnesium, aluminum, chromium, iron, manganese, and nickel. No COIs in the background sample exceeded human health or ecological screening criteria. Similarly, COI concentrations in samples from South Fork Mill Creek and the ephemeral tributary were all below ecological screening criteria. However, COI concentrations in sediment samples from the adit discharge and ponds exceeded one or more ecological screening criteria for cadmium, copper, lead, and zinc. The results are summarized below:

- In the adit discharge sample (SD-AD1-C-01), cadmium and zinc concentrations exceeded all of the ecological screening criteria; copper and lead concentrations exceeded WDOE's Freshwater Sediment Quality Criteria. The lead concentration also exceeded the EPA Threshold Effects Level (TEL).
- In the sample from the small pond (SD-PD1-C-01), cadmium, lead, and zinc concentrations exceeded WDOE's Freshwater Sediment Quality Criteria; cadmium and zinc also exceeded the EPA TELs.
- In at least one of the samples from the large pond (SD-PD2-C-01 and 02), cadmium, copper, lead, and zinc concentrations exceeded WDOE's Freshwater Sediment Quality Criteria; cadmium, lead, and zinc also exceeded the EPA TELs.
- Metals concentrations in samples from the background seep, ephemeral tributary, and South Fork Mill Creek did not exceed any screening criteria.
- TOC in the sediment samples ranged from 1.63 to 6.94 percent and total carbon content ranged from 3.26 to 7.24 percent; pH values ranged from 6.67 to 7.33.

## 4.5 Surface Water

Analytical results of the surface water samples are presented in Table 10. Only one background surface water sample was collected (SW-BG1-01). Besides the major cations (calcium, potassium, magnesium, and sodium), the only COI detected in the background sample was barium at 0.012 milligram per liter (mg/L). This concentration exceeds EPA's Recommended Chronic Ambient Water Quality Criteria for Protection of Aquatic Life (EPA 2004b) and ORNL's Ecological Screening Level for Freshwater (both 0.004 mg/L) (Efroymson *et al.* 1997). All other COIs were below the reporting limit.

Nearly all COIs were undetected in the surface water samples. With the exception of the major cations (calcium, potassium, magnesium, sodium), the only metals with detectable concentrations were barium, manganese, and zinc. The results are summarized below:

- Barium exceeded EPA's Recommended Chronic Ambient Water Quality for Protection of Aquatic Life and ORNL's Ecological Screening Level for Freshwater (both 0.004 mg/L) in 8 of the 10 samples, including the background sample, and ranged from 0.003 to 0.015 mg/L.
- Manganese was detected in four samples at concentrations ranging from 0.005 to 0.016 mg/L, well below both human health and ecological screening criteria.
- Zinc was detected in only two samples and concentrations in both samples (0.038 and 0.066 mg/L) exceeded ORNL's Ecological Screening Level for Freshwater (0.03 mg/L).
- Hardness ranged from 116 to 226 milligrams $CaCO_3$ per liter (mg $CaCO_3$/L), and $E_h$ ranged from 200 to 399 millivolts (mV).

## 4.6 Pore Water

Analytical results of the pore water samples are summarized in Table 11. With the exception of the major cations (calcium, potassium, magnesium, and sodium) the two pore water samples contained detectable concentrations of only three metals: barium, iron, and manganese. The results are summarized below:

- Both samples exceeded the ORNL Ecological Screening Level for Freshwater for barium (0.004 mg/L).
- The manganese concentration in one sample exceeded the ORNL Ecological Screening Level for Freshwater (0.05 mg/L), EPA's Recommended Chronic Ambient Water Quality for Protection of Aquatic Life and ORNL's Ecological Screening Level for Freshwater (both 0.12 mg/L).
- Hardness ranged from 108 to 120 mg $CaCO_3$/L, and Eh ranged from 198 to 212 mV.

## 4.7 Aquatic Survey

Scientific reference data for ephemeral stream habitats is very limited making it difficult to accurately assess aquatic habitat in the ephemeral tributary. For this reason, the aquatic survey focused on South Fork Mill Creek, which is a perennial stream. Riparian vegetation along South Fork Mill Creek includes dense willow and alder thickets comprising the riparian canopy with immense mats of *carex* and *juncus* spp. encompassing the understory. Wetlands were very expansive and created a wide floodplain. Further removed from the bank, the river is surrounded by mature coniferous forest.

The upstream and downstream habitat reach locations consisted of a series of beaver dams creating many braided channels. Pools dominated the habitat type consisting of approximately 90 to 95 percent of the stream characteristics. The lengths, widths, and depths of pools varied throughout the survey. However, pool habitat associated with the upstream reach was generally deeper than the downstream reach. Substrate related with both reaches was consistently the same. Because of the lack of velocity associated with the beaver dams significant accumulations of sediment have built up over time. Pool substrate typically consisted of a thick mud and sand mixture. Sediment accumulations were generally in excess of 1.5 to 2.5 feet thick. Gravels, cobbles, and boulders were not observed in any pools in this survey.

Riffle habitat was very limited throughout the entire survey. When riffle habitat was present it consisted of spilling/leaking over the adjacent upstream beaver dam. Riffle habitats were extremely short in length compared to pools (< 5 meters). When present, riffles exhibited many of the same characteristics as the pool habitats. Sediment accumulations were also in excess of 1.5 to 2.5 feet thick. Gravels, cobbles, and boulders were not observed in riffle sections included in this survey.

EPA habitat assessment scores were comparable between the two reaches. The upstream habitat scored 169 out of a possible 200, and the downstream habitat scored 158 out of a possible 200. Shallower and smaller pools caused the downstream reach to score lower. Both reaches appeared in good condition with the exception of the lack in diversity of pool to riffle habitat and uniform depth regime.

Overall, the sections of South Fork Mill Creek appear to be healthy. The stream appears to be functioning near its potential. The complexes of beaver dams in this region have dramatically increased the wetland area surrounding South Fork Mill Creek. Well-established riparian and surrounding habitats have produced a productive environment for a variety of aquatic species. There is no evidence of degradation to this section of South Fork Mill Creek caused by mining related activities associated with the Longshot Mine. Any surface water from the proximity of Longshot Mine that reaches South Fork Mill Creek will be filtered naturally by the presence of an expansive wetland area related to the presence of beaver dams. This is evident by the relatively similar habitat scores between the two reaches.

In summary, the following habitat conditions were noted in the aquatic survey:

- Both stream reaches (upstream and downstream) were significantly impacted by beaver dams. Velocity/flow was not measured because of the lack of moving water; which also made cross section evaluations impractical.
- Habitat scores of 158 and 169 indicate suboptimal physical habitat conditions for both reaches. The downstream reach generally consisted of shallower pools than the upstream reach, which negatively affected the overall habitat score.
- Riffle habitats were very limited because of the large beaver pond complexes. Riffles were generally only present due to spillage/leakage of the associated upstream beaver dam.

Water chemistry data recorded in the field during the aquatic survey and macroinvertebrate sample collection are summarized in Table 12.

### 4.8 Benthic Macroinvertebrates

The macroinvertebrate samples were sorted and subsampled using a Caton type sample splitter. Large debris and inorganic sediment was inspected for attached invertebrates and removed from the sample. A 300-count subsample was utilized for this project and macroinvertebrates were identified to the lowest practical level. This included Chironomidae to genus/species and Oligochaeta to species. Macroinvertebrates were identified using published taxonomic keys. Laboratory enumeration was completed for up to 500 individuals in each sample. Results from the samples collected from pool habitats were only compared to other pool results and riffle results were only compared to other riffle results. A summary of the macroinvertebrate results for the pool samples is provided in Table 13. Results of the benthic macroinvertebrate investigation for pool habitats suggest that:

- The abundance of invertebrates was dominated by different species between the two reaches. The Order Chironomidae (midges), represented over half of the taxa for the sample (55 percent), and dominated the upstream sample (05MSE02), while the downstream sample (05MSE04) is much more diverse. The dominant taxa in the downstream pool reach consisted of the Order Hemiptera, Family Corixidae (33 percent) (Water boatmen) and the Order Ephemeroptera (Mayflies), Family Baetidae (23 percent).
- Benthic Invertebrate Index of Biological Integrity (BIBI) (modified Karr 1998) index scores indicate low biological integrity for both sample locations with scores of 20 for the upstream location and 14 for the downstream location.
- Total invertebrate abundance was in the normal range (i.e. 1,000 to 10,000 per square meter) for both pool samples.
- Total taxa richness was low for the upstream and the downstream sample locations with values of 35 and 40, respectively.
- Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT) taxa richness counts were the same for both the upstream and the downstream samples, but were very low (5).
- The diversity of functional feeding groups and species diversity in pool samples were consistent across both samples. The number of species of collector-gatherers and predators far outnumber other functional feeding groups.

Results of the benthic macroinvertebrate investigation for riffle habitats are summarized in Table 14 and suggest that:

- The abundance of all invertebrates for both upstream (05MSE01) and downstream (05MSE03) samples was dominated by the Order Chironomidae (midges).
- One intolerant Chironomidae midge taxa was present in the upstream riffle sample. Intolerant taxa are those that require high dissolved oxygen and cool/cold water temperatures.
- BIBI index scores (modified Karr 1998) indicate low biological integrity for the upstream sample location with a score of 20. The downstream riffle sample scored a 26 on the BIBI, indicating moderate to borderline low biological integrity for this stream reach.
- The total taxa richness was low for the upstream sample (33) and moderate for the downstream (53).
- One particular note is the extremely low density of total invertebrate abundance in the upstream riffle sample (165). This could be because of the lack of suitable riffle habitat as described under the Aquatic Survey in Section 4.7.
- EPT counts were very low for the upstream and the downstream samples, with values of 3 and 7, respectively.

- The diversity of functional feeding groups and species diversity in riffle samples were consistent across both samples. The numbers of species of collector-gatherers outnumber other functional feeding groups.

### 4.9 Data Quality Review

The analytical laboratory (SVL) conducted quality assurance (QA) consistent with the published methods, in accordance with its Quality Assurance Plan. Internal QA procedures included the use of method blanks, laboratory control samples (LCS) and post-digestion spikes, as appropriate to the individual methods. In addition, MSE submitted selected samples for matrix spike/matrix spike duplicate (MS/MSD) analysis. In MS/MSD analysis, the laboratory spikes two portions of the raw sample with a known amount of each analyte, then subjects the spiked and unspiked samples to the entire analytical procedure. The percent recovery (%R) and relative percent difference (RPD) results allow an assessment of both accuracy and precision of the combined sampling/analytical system.

Review of the QA data provided by SVL indicated that all internal requirements were met, except that one calcium spike exceeded the linear range of the instrument (because of the high calcium concentration in the unspiked sample). Because calcium is not a toxic element and the result was used only to calculate hardness, a repeat analysis under 10x dilution was not requested. The results for MS/MSD pairs showed recoveries outside of the 75 to 125 percent acceptance range for silver, aluminum, calcium, iron, magnesium, manganese, antimony, lead, zinc in some analytical batches. In most cases, this was caused by a spike greater than four times the unspiked analyte concentration, which is outside the range for which the MS/MSD analysis is informative. However, review of the RPDs and the LCS and post–digestion spike results indicates that the analytical system was "in control," and the reported concentrations are suitable for use in the streamlined risk assessments.

## 5.0 STREAMLINED RISK EVALUATION AND ASSESSMENT

An initial risk screening and streamlined human health and ecological risk assessments were completed for the Longshot Mine and Mill site. The initial risk screening is independent of the streamlined risk assessments and was performed as a very simplified risk evaluation to determine if further assessment was warranted. The initial risk screening and streamlined risk assessments are discussed in the following sections. The complete streamlined human health risk assessment (HHRA) is provided as Appendix A, and the ERA is provided as Appendix B.

### 5.1 Initial Risk Screening

The initial risk screening involves comparing COI concentrations in the mine waste, surface water, and sediment samples to BLM's Risk Management Criteria (RMC) to provide a preliminary assessment of potential risks to human health and ecological receptors at the site, and to determine if further risk assessment is warranted. The RMCs are risk-based screening levels for human and ecological exposure to COIs in various media, developed by the BLM specifically for application to abandoned mining sites (Ford 1996). The risks are classified in logarithmic categories, with relative risk expressed in terms of the factor by which contaminant concentrations exceed the reference RMC. The RMCs were developed using available toxicity data and standard EPA exposure factors. The intent of RMCs is to provide a baseline concentration, below which adverse health effects from exposure to metals in soil, sediment and water at abandoned mine sites will not occur.

The BLM human health RMCs correspond to either a target excess cancer risk level of 1.E-05, or a target noncancer Hazard Index (HI) of 1.0. For metals posing both carcinogenic and noncancer threats to health, the lower (more protective) concentration is used for the RMC. For a target excess cancer risk of 1.E-05, an individual exposed at the RMC under the BLM exposure conditions, would have a 1 in 100,000 chance to develop any type of cancer in a lifetime as a result of contact with the metal of concern. An HI of <1.0 is assigned when the dose of noncancer metals assumed to be received at the site by any of the receptors is lower than the dose that may result in adverse noncancer health effects. The RMCs are protective for exposures to multiple chemicals and media. Because of the limited available toxicological information regarding health risks associated with exposure to lead, the lead RMC was determined from the EPA Integrated Exposure Uptake Biokinetic (IEUBK) Model and other EPA regulations and guidance (Ford 1996).

Ford developed RMCs for ecological receptors from a survey of literature for toxicity data relevant to either wildlife receptors at BLM sites or to closely related species. For receptors without available toxicity data, he selected data based on phylogenetic similarity between ecological receptors and the test species for which toxicity data were reported. He obtained soil ingestion data for each receptor from a study on dietary soil content of wildlife from the FWS. For receptors without available dietary soil content data, he assumed soil content was equal to that of an animal with similar diets and habits. The amount of soil ingested by each receptor was estimated as a proportion of their daily food intake. Ford then calculated the food intake in grams for each receptor as a function of body weight.

Ford calculated RMCs for metals in soil based upon assumed exposure factors for the specific receptors, and species- and chemical-specific toxicity reference values (TRVs). The TRVs represent daily doses of the metals for each wildlife receptor that will not result in any adverse toxic effects. Ford computed the metals TRVs for each wildlife receptor/metal combination for which toxicity data were available. Phylogenetic and intraspecies differences between test species and ecological receptors were accounted for by applying uncertainty factors derived from critical toxicity values. These uncertainty factors were applied to protect wildlife receptors that might be more sensitive to the toxic effects of a metal than the test species. The uncertainty factors were applied to the test species toxicity data in accordance with a method developed by BLM. In accordance with this system, Ford applied a divisor of two to the toxicity reference dose for each level of phylogenetic difference between the test and wildlife species (in essence, individual, species, genus, and family).

Results of the RMC screening are presented in Table 15. There appears to be moderate risk to human receptors from exposure to antimony, arsenic and cadmium, and high risk from exposure to lead in mine waste at the site. However, the MDCs for both antimony and cadmium were well below EPA's Region IX Industrial Soil PRGs. There does not appear to be any human health risk from exposure to sediment for surface water. Ecological RMCs are provided only for soil. Potential ecological receptors show high to extremely high risk from metals in the mine waste, particularly lead, zinc, and cadmium. There is also risk to the robin from exposure to arsenic and copper in the mine waste. However, the robin also shows risk from exposure to background soil concentrations of arsenic, cadmium, copper, lead, and zinc.

### 5.2 Streamlined Human Health Risk Assessment

A streamlined HHRA was conducted to assess and evaluate potential risks associated with exposure to mining-related contaminants at the Longshot Mine. The HHRA evaluated potential impacts to human health resulting from exposure to site-related contaminants of potential concern (COPCs) in mine wastes, sediment, and surface water at the site. The results were used to identify areas and media posing significant risks to potential human receptors at the site. Both reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios were evaluated. The RME scenario is intended to be a very conservative estimate of potential exposure at the site while the CTE scenario is typically more realistic. The risk assessment was completed in general accordance with EPA's "*Risk Assessment Guidance for Superfund (RAGS), Volumes 1 and 2*" (EPA 1991).

The following sections briefly discuss the risk assessment methodology and assumptions, and summarize the estimated human health risks and hazards. A more detailed discussion of the HHRA is provided in Appendix A.

### *5.2.1 Data Summary and Evaluation*

Data used in the HHRA consisted of analytical results from mine waste, soil, sediment, and surface water samples collected during the SI. All data were assumed to be of sufficient quality for the purposes of this risk assessment.

### *5.2.2 Potential Receptors and Exposure Routes*

Because of the remote location, potential uses are limited and long-term exposure to contaminants at the site is unlikely. Recreational use appears to be limited to hunters and hikers that traverse the site. Therefore, the potentially exposed populations evaluated in this risk assessment were limited to adult and child recreationalists. Potential exposure pathways for a recreational receptor evaluated in this risk assessment include:

- Incidental ingestion of soil and sediment
- Incidental Ingestion of surface water
- Dermal contact with soil, sediment, and surface water
- Inhalation of soil particulates

Other potentially complete pathways, such as fish, groundwater, and plant ingestion, were qualitatively considered but not quantified as discussed in Appendix A.

### *5.2.3 Contaminants of Potential Concern*

COPCs are compounds at the site that exceed risk-based screening levels and are used to evaluate potential risks to human receptors. In accordance with EPA guidelines (2004b), analytical data from the site for each media were screened on the basis of detection frequency, background levels, and regulatory criteria to identify site-specific COPCs for use in the risk assessment. Based on the results of the screening process, the compounds presented in Table 16 were identified as COPCs for the Longshot Mine.

### *5.2.4 Exposure Point Concentrations*

Exposure point concentrations (EPCs) were developed from site-specific data and represent the concentration of each COPC that a receptor will potentially contact during the exposure period. For the RME scenario, the $UCL_{95}$ of the arithmetic mean was used because of the uncertainty associated with estimating the true average concentration at a site. The $UCL_{95}$ were calculated using EPA's PROUCL statistical program. The program computes UCLs for each data set using several methods and recommends one based on the data distribution. However, data sets with fewer than 10 data samples can provide statistically unreliable estimates of the true average and may occasionally exceed the MDC. In those instances, the MDC was used. For the CTE scenario, the arithmetic mean concentration was used as the EPC for all media in accordance with EPA guidance. The EPCs used in the Longshot Mine HHRA are summarized in Table 17.

### *5.2.5 Hazard and Risk Estimates*

Potential human health impacts associated with exposure to COPCs at the Longshot Mine were evaluated by estimating both non-carcinogenic and carcinogenic effects. Non-carcinogenic hazards were evaluated by comparing estimated chronic daily intakes (CDIs) to EPA-established reference doses (RfD). RfDs represent route-specific estimates of the safe dosage for each COPC over a lifetime of exposure. Chronic RfDs were used in this HHRA and represent the highest average daily exposure to a human receptor that will not cause deleterious effects during their lifetime. The ratio of the estimated CDI to the RfD is the Hazard Quotient (HQ). HQs are calculated for each COPC with an established RfD. For exposure to multiple COPCs, the individual HQs are summed for all contaminants with similar health effects in each exposure pathway to determine the HI. HQs or HIs greater than 1.E+00 indicate the potential for adverse health effects because the estimated intake exceeds the RfD.

The carcinogenic risk from exposure to a COPC is expressed in terms of the probability that an exposed receptor will develop cancer over his lifetime. Carcinogenic risks are estimated by multiplying the CDI by Slope Factors (SFs) developed by the EPA. SFs convert the CDI, averaged over a lifetime of exposure, to a risk of developing cancer, commonly referred to as the excess cancer risk (ECR). SFs are chemical– and route–specific and represent an upper bound individual excess lifetime cancer risk.

Risks from exposure to lead cannot be quantified using standard risk assessment algorithms because lead RfDs and SFs have not been established by the EPA. In addition, lead exposure models developed by the EPA were developed to assess exposures under chronic, steady-state conditions such as a working environment, school, or residence. The models are not intended to be used for acute, short-term exposures such as those associated with occasional recreational use of a remote site. Therefore, because exposures at the site are expected to be short-term and occasional, the lead exposure models were not used and lead risks were not quantitatively evaluated. However, lead risks were qualitatively evaluated by comparing lead concentrations at the site to EPA screening criteria and RMCs developed by the BLM. This process identified specific areas and media posing potential human health risks from exposure to lead at the site.

Non-carcinogenic hazard and carcinogenic risks were calculated for all receptors using both RME and CTE scenarios. The RME scenario uses very conservative assumptions and represents the maximum potential exposure that could occur at a site. RME estimates typically provide the basis for developing protective exposures for future land uses. The CTE scenario employs more realistic assumptions and is usually considered more representative of actual exposures.

The estimated non-carcinogenic hazards and carcinogenic risks from exposure to COPCs at the Longshot Mine are discussed in the following sections and summarized in Table 18.

#### *5.2.5.1 Summary of Non-carcinogenic Hazards*

The estimated non-carcinogenic hazards were compared to an acceptable HI of less than or equal to 1.E+00 (WDOE 2001a). The results indicated very low non-carcinogenic hazards to adult and child recreationalists at the Longshot Mine under both the RME and CTE scenarios. The total cumulative non-carcinogenic hazards were below 1 for both receptors for all media and exposure pathways. For the adult, the total HI was 1.E-03 under the CTE scenario, and 5.E-03 under the RME scenario. For the child, the total HI was 1.E-02 under the CTE scenario, and 1.E-01 under the RME scenario.

#### 5.2.5.2 *Summary of Carcinogenic Risks*

Of the human health COPCs evaluated in this HHRA, arsenic is the only carcinogen for which cancer risks were estimated; lead may also be considered a carcinogen but cancer risks cannot be quantified for lead. Therefore, the estimated carcinogenic risks were compared to an acceptable risk level of less than or equal to one in one million (ECR ≤ 1.E-06) for exposure to a single carcinogen (WDOE 2001a). The results indicated below acceptable level carcinogenic risks to an adult recreationalist under both the RME (ECR = 9.E-07) and CTE (ECR = 6.E-08) scenarios. For the child recreationalist, the results showed low carcinogenic risk under the RME scenario (ECR = 4.E-06) and below acceptable level risk under the CTE scenario (ECR = 4.E-07).

#### 5.2.5.3 *Lead Risks*

The EPA has not specified a hazardous waste threshold value for total lead in soil and has not established a drinking water maximum contaminant level (MCL) for lead; however, it suggests lead screening levels of 800 mg/kg for industrial soils and 0.015 mg/L for drinking water. Although lead was not detected in surface water at the site, 12 mine waste samples exceeded EPA's suggested soil screening level. Of those 12 samples, 11 also exceeded the BLM RMC of 1,000 mg/kg for lead in soils based on a camper receptor (Ford 1996) and 3 had lead concentrations greater than 10 times the RMC indicating high relative risk. Based on the mine waste sample results, lead EPCs for the CTE and RME scenarios would be 5,371 mg/kg and 13,194 mg/kg, respectively. Therefore, exposure to lead in the mine waste likely poses a significant risk to human receptors at the site.

#### 5.2.5.4 *Hotspot Assessment*

At most hazardous sites, typically a small percentage of the area is highly contaminated and contributes to a large percentage of the overall site contamination and exposure risk. These hotspots are areas where the contamination is highly concentrated, highly mobile, or cannot be reliably contained. Identification and treatment or removal of these hotspots can significantly reduce the overall risk to receptors at the site. At the Longshot Mine, 3 of the 11 mine waste samples had lead concentrations significantly higher than the remaining samples. Lead concentrations in the two areas where these samples were taken from (unprocessed ore bin and waste rock pile WR2) contribute considerably more risk than any of the other areas. For example, if these three samples are removed, the average lead concentration in the mine waste decreases from 5,371 to 1,287 mg/kg, which represents moderate risk. Therefore, these areas should be considered isolated hotspots.

### 5.3 Streamlined Ecological Risk Assessment

A screening level ERA was conducted to assess and evaluate potential ecological risks associated with exposure to mining-related contaminants at the site. The ERA evaluated potential impacts to ecological receptors resulting from exposure to site-related contaminants in mine wastes, sediment, surface water, and pore water. The results were used to identify areas and media posing elevated risks and to assist in the development and evaluation of remedial alternatives to mitigate potential impacts. The ERA was completed in substantial conformance with EPA's *"Guidelines for Ecological Risk Assessment"* (1998). The ERA report is provided in Appendix B and includes:

- List of COIs based on data collected during the field investigation;

- Description of the site ecology and ecological receptors (including T&E, and sensitive species) potentially occurring in the vicinity of the site;
- Conceptual site exposure model;
- List of the assessment and measurement endpoints;
- Description of the methodologies used in the ecological risk-based screening;
- Description of the uncertainties involved in the ERA; and
- Risk characterization summarizing the primary contaminants posing risk to ecological receptors.

### *5.3.1 Ecological Risk Assessment Summary*

The streamlined ERA involved identifying potential contaminants of ecological concern (CPECs) and calculating ecological risk ratios for ecological receptors in each media. Potential ecological risk from exposure to each COI was assessed using media-specific risk ratios calculated by dividing the EPC by the SLV. The risk ratios were then compared to receptor-specific risk ratios (Q-factors) to evaluate potential ecological risk. In general, higher risk ratios present a greater likelihood that a CPEC concentration will adversely affect ecological receptors. Risk ratios greater than 1 (Q=1) indicate potential risk for protected (i.e., federally listed T&E species) while risk ratios greater than 5 (Q=5) indicate potential risk to non-protected receptors. A Q-factor of 5 was used in this streamlined ERA because, although T&E species have been identified in the Colville National Forest, there appears to have been no documented occurrences at the site and none were observed during the field investigation. COIs with risk ratios greater than 5 were retained as CPECs. Several COIs also were retained because of the lack of established screening level values (SLVs). The potential ecological risk posed by these CPECs, if any, cannot be quantified.

Results of the streamlined ERA indicate some potential risk to ecological receptors at the Longshot Mine site. However, these risks appear to be limited to individual receptors and there does not appear to be any population-level risks. While individual receptors may be at risk from exposure to CPECs at the site, their populations are unlikely to be significantly impacted in the vicinity of the mine because it is unlikely that entire populations would reside entirely within the contaminated areas of the site. These areas typically offer lower habitat quality compared to adjoining habitat; therefore, it is unlikely that a receptor would limit its habitat strictly to these areas.

Table 19 summarizes the identified CPECs and Table 20 presents an overall summary of the human health and ecological contaminants of potential concern. The following sections discuss the CPECs and ecological risk ratios by media type.

#### *5.3.1.1 Mine Waste*

Fourteen COIs in mine waste were identified as CPECs: aluminum, antimony, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, silver, vanadium, zinc, and cyanide. Of these, lead and zinc can be considered the most significant CPECs because they pose a potential threat to all four of the ecologic receptor groups (plants, invertebrates, birds, and mammals). Of the 14 COIs, 11 COIs were retained because their risk ratios were greater than 5. The remaining three COIs were retained as CPECs because of the lack of SLVs (chromium, mercury, and cyanide).

Invertebrates were the most susceptible receptor group (10 CPECs identified), particularly to cadmium, lead, silver, and zinc, which all had risk ratios exceeding 100. The vegetation ecological group was susceptible to risk from seven CPECs, particularly aluminum, lead, and zinc, which all had risk ratios exceeding 100. Four CPECs were identified as posing risk to the bird ecological receptor group, particularly lead and zinc which had risk ratios exceeding 100. Lead and zinc were the only CPECs identified as posing risk to the mammals ecological receptor group, and both had risk ratios exceeding 100. Lead and zinc were also identified as CPECs based on multiple COI risk.

The primary CPECs posing risk to three or more ecological receptor groups at the site are aluminum, cadmium, lead, and zinc. Of these, lead poses the most significant risk to all ecological receptors groups with risk ratios ranging from 112 to 888.

#### *5.3.1.2 Surface Water and Pore Water*

Risk posed to wildlife and avian receptors from exposure to contaminated surface water and pore water is not elevated (risk ratios less than the Q-factor). No CPECs were identified in pore water and only two were identified in surface water: barium and zinc. Risk ratios for both CPECs did not exceed 0.01 for any receptor groups. These results indicate that the surface water at the Longshot Mine poses very little risk to potential ecologic receptors at the site.

#### *5.3.1.3 Sediment*

Nine CPECs were identified in sediment: aluminum, barium, cadmium, cobalt, iron, manganese, silver, vanadium, and zinc. Of these 9 CPECS, 7 were retained because of the lack of SLVs. Only two pose a risk to aquatic receptors because of either direct exposure or bioaccumulation: cadmium and zinc. Of these two, cadmium poses the greatest risk because of a bioaccumulation risk ratio of 1,499. The highest metals concentrations were in sediment samples from the adit discharge and ponds. Overall, the presence of elevated metal concentrations in the sediment indicates there is some risk to aquatic macroinvertebrates.

## 6.0 CONCLUSION AND RECOMMENDATIONS

Analytical results of samples collected during the field investigation indicate elevated concentrations of several metals in the tailings and waste rock. Metals concentrations in the background soil and sediment samples were significantly lower and nearly all metals were undetected in the surface water samples. Potential acid generation in the mine waste is very low. There is no obvious evidence of contaminant migration from the site or impacts to South Fork Mill Creek from the Longshot Mine.

Results of the streamlined HHRA indicate significant risk from exposure to metals in mine wastes at the site. The most significant exposure pathway is ingestion of and dermal contact with the mine waste. Inhalation of particulates from the mine waste, and ingestion of and dermal contact with surface water contribute minimal risk and are insignificant pathways. Two human health COPCs were identified: arsenic and lead. Arsenic poses carcinogenic risk only to the child receptor and only under the RME scenario. Lead risks were not quantified because of the lack of established toxicological data and the limitations of current lead exposure models. However, lead concentrations were compared to EPA human health screening criteria and BLM RMCs to evaluate potential risks from exposure to lead at the Longshot Mine. Because the lead MDC in the mine waste is more than 30 times the EPA human health screening level, there appears to be significant but relatively isolated risk to both the adult and child receptors from exposure to lead at the site.

Results of the streamlined ERA indicate significant potential risk to ecological receptors at the site; however, the risks are limited to individual receptors rather than at the population level. This is because while individual receptors may be exposed to metals in mine wastes at the site, their populations are unlikely to be significantly impacted because it is improbable that entire populations of receptors reside strictly within the site boundaries. Several CPECs were identified and the highest risk ratios are for metals in the mine waste, particularly aluminum, cadmium, lead and zinc. There also appears to be limited risk to individual aquatic receptors at the site from exposure to metals concentrations in sediment, and very limited risk from exposure to surface water or pore water at the site.

Based on results of the streamlined risk assessments, human health risks from exposure to metals, particularly arsenic and lead, in the mine waste are a significant concern and will likely warrant a removal action. Addressing or mitigating the human health risks through a removal action should also address potential ecological risks. Risk-based cleanup criteria can be back calculated using the exposure factors and risk equations used in the HHRA. Based on the most sensitive receptor (child recreationalist) under the RME scenario and an acceptable cleanup carcinogenic risk level of 1.E-05 for total cumulative risk, the arsenic soil cleanup level is 52 mg/kg. The arsenic MDC in mine waste (41 mg/kg) is below the cleanup level; therefore, none of the mine waste piles would require removal based on the proposed arsenic cleanup level. Because lead risks were not quantified using standard risk equations, a risk-based lead cleanup level could not be established. However, established state and federal lead screening levels for protection of human health are risk-based and provide a point of reference. The EPA Region IX Industrial Soil PRG for lead is 800 mg/kg, and WDOE's MTCA Industrial Soil Cleanup Level for lead is 1,000 mg/kg. However, these values were established based on a worker scenario with chronic exposure so they may be overly conservative for a remote site with recreational exposures. A specific soil cleanup level for lead may be difficult to determine but should take into consideration site-specific factors and limited exposure based on recreational uses.

Two mine waste areas at the site were identified as potential hotspots, *i.e.,* areas that are highly contaminated and contribute to a large percentage of the overall exposure risk at the site. Lead concentrations in mine waste samples from these two areas (unprocessed ore bin and waste rock pile WR3) are significantly higher than the other areas and range from 16,000 to 30,000 mg/kg. In addition, mine waste samples from those two areas also contain the highest concentrations of several other metals including zinc, cadmium, copper and antimony. Removal of the mine waste from those two areas would decrease the average lead concentration at the site from 5,371 to 1,278 mg/kg and significantly decrease the overall site risk. The estimated volume of unprocessed ore and waste rock in those two areas is about 110 $yd^3$. The total estimated volume of mine waste at the site is about 3,200 $yd^3$.

There are several significant physical hazards at the site, including the two open adits, vertical stope, a vertical rock face surrounding the stope, unstable mill frame and several collapsed wooden structures, and the wood and metal debris scattered throughout the site. Measures should be taken to remove or mitigate physical hazards at the site, particularly the open adits and stope.

Based on the results of this SI, MSE recommends performing a streamlined Engineering Evaluation/Cost Analysis (EE/CA) to address physical hazards at the site and lead concentrations in the mine waste.

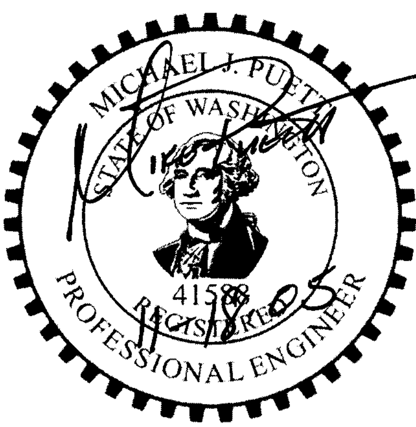
**DISCLAIMER**

This abandoned mine/mill site was created under the General Mining Law of 1872 and is located solely on National Forest System (NFS) lands administered by the USFS. The United States has taken the position and courts have held that the United States is not liable as an "owner" under CERCLA Section 107 for mine contamination left behind on NFS lands by miners operating under the 1872 mining law. Therefore, USFS believes that this site should not be considered a "federal facility" within the meaning of CERCLA Section 120 and should not be listed on the Federal Agency Hazardous Waste Compliance Docket. Instead, this site should be included on EPA' CERCLIS database Consistent with the June 24, 2003 OECA/FFEO "Policy on Listing Mixed Ownership Mine or Mill Sited Created as a Result of the General Mining Law of 1872 on the Federal Agency Hazardous Waste Compliance Docket," we respectfully request that the EPA Regional Docket Coordinator consult with the USFS and EPA Headquarters before making a determination to include this site on the Federal Agency Hazardous Waste Compliance Docket.

Prepared by:

**Millennium Science and Engineering, Inc.**

Michael J. Puett, P.E.
Principal Author




EXPIRES 9-27-07

**Millennium Science and Engineering, Inc.**

Michael L. May
Technical Reviewer

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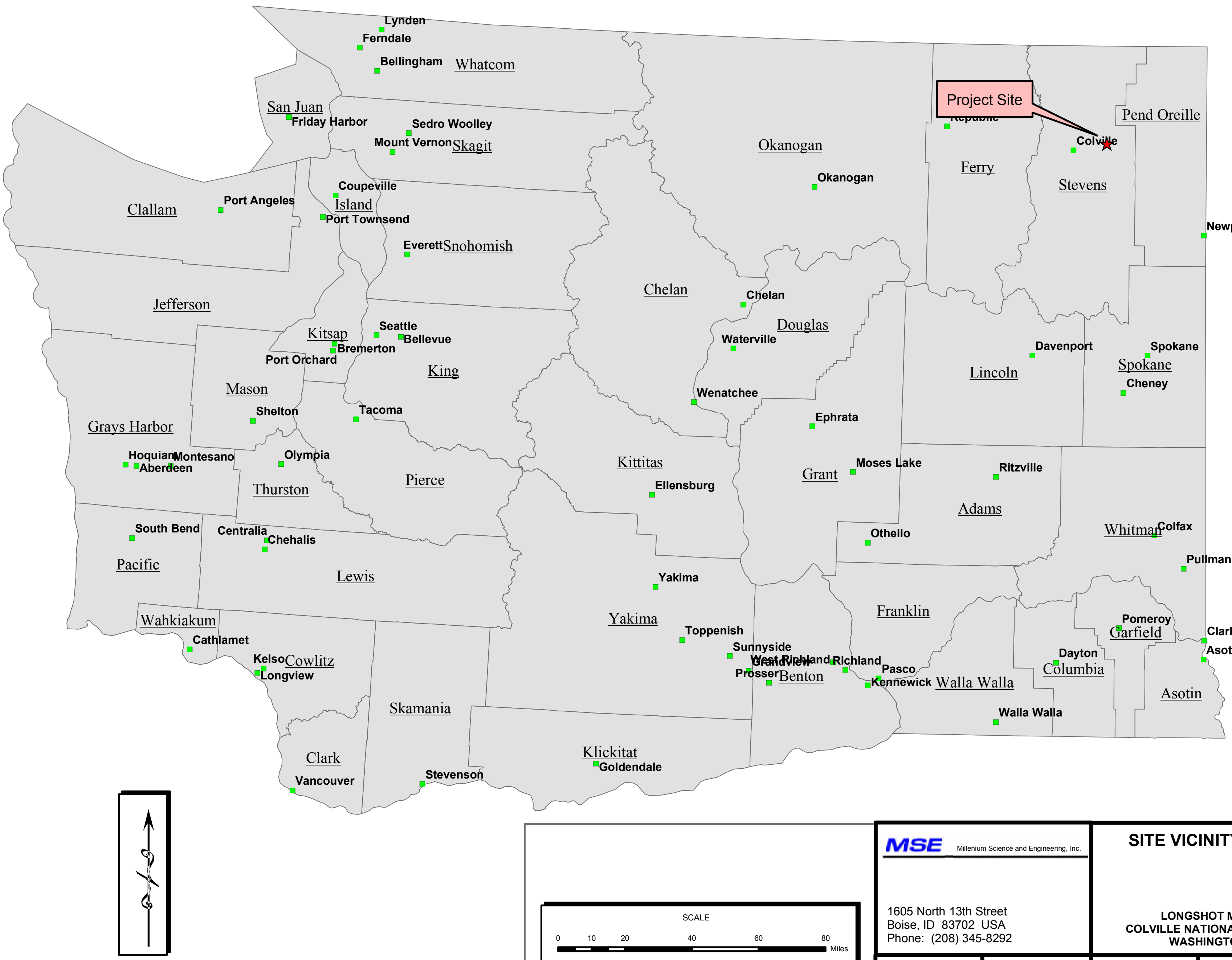
**FIGURES**




**MSE** Millenium Science and Engineering, Inc.

1605 North 13th Street
Boise, ID 83702 USA
Phone: (208) 345-8292

## SITE VICINITY MAP

**LONGSHOT MINE**
**COLVILLE NATIONAL FOREST**
**WASHINGTON**

| B2473B | 9-29-05 | MSE | FIGURE 1 |
|---|---|---|---|

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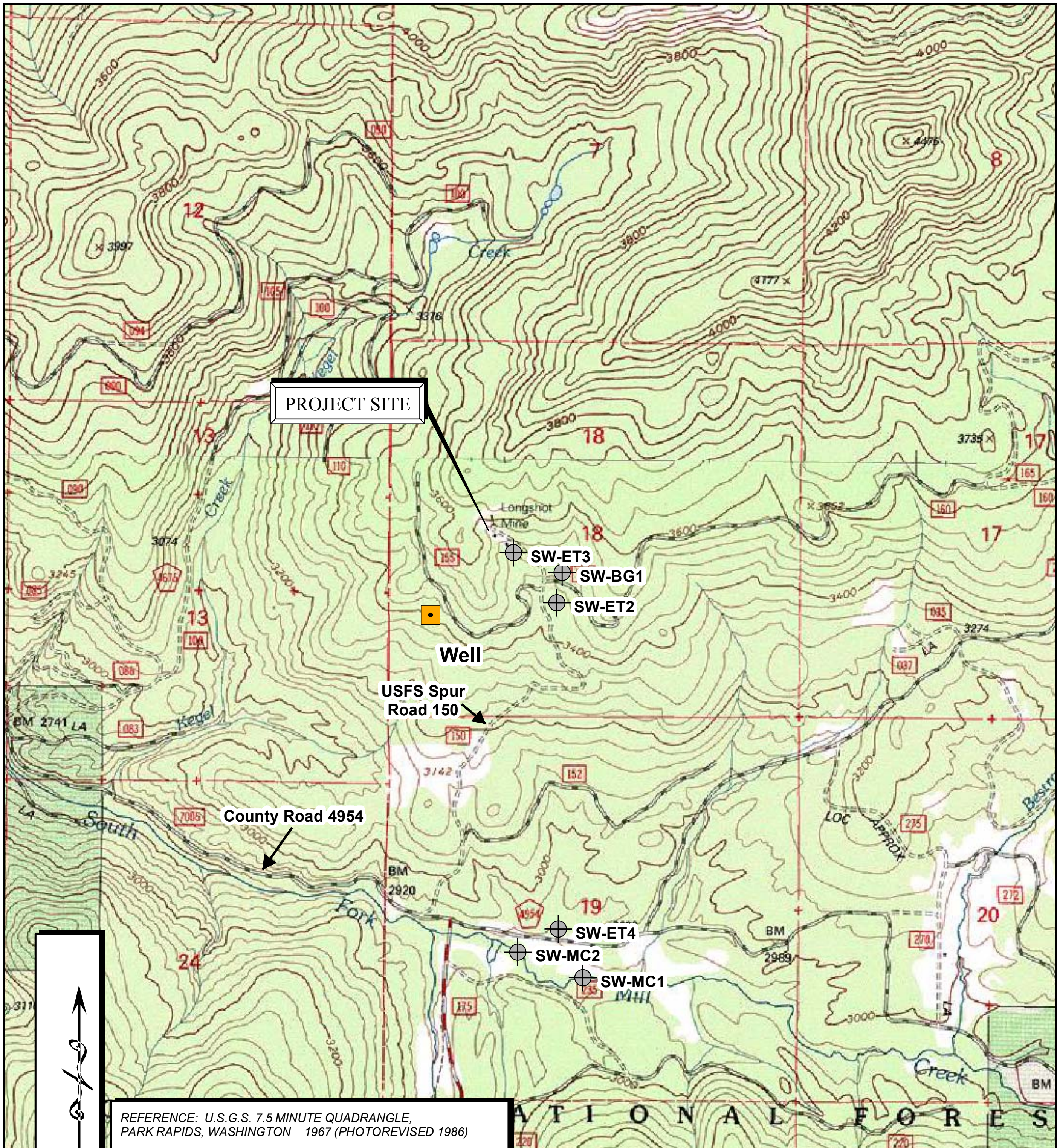


Legend

- Sample Locations
- Well Locations

SCALE

0 0.125 0.25 0.5 0.75 1

Miles

0 500 1,000 2,000 3,000 4,000 Feet

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Boise, ID 83702 USA
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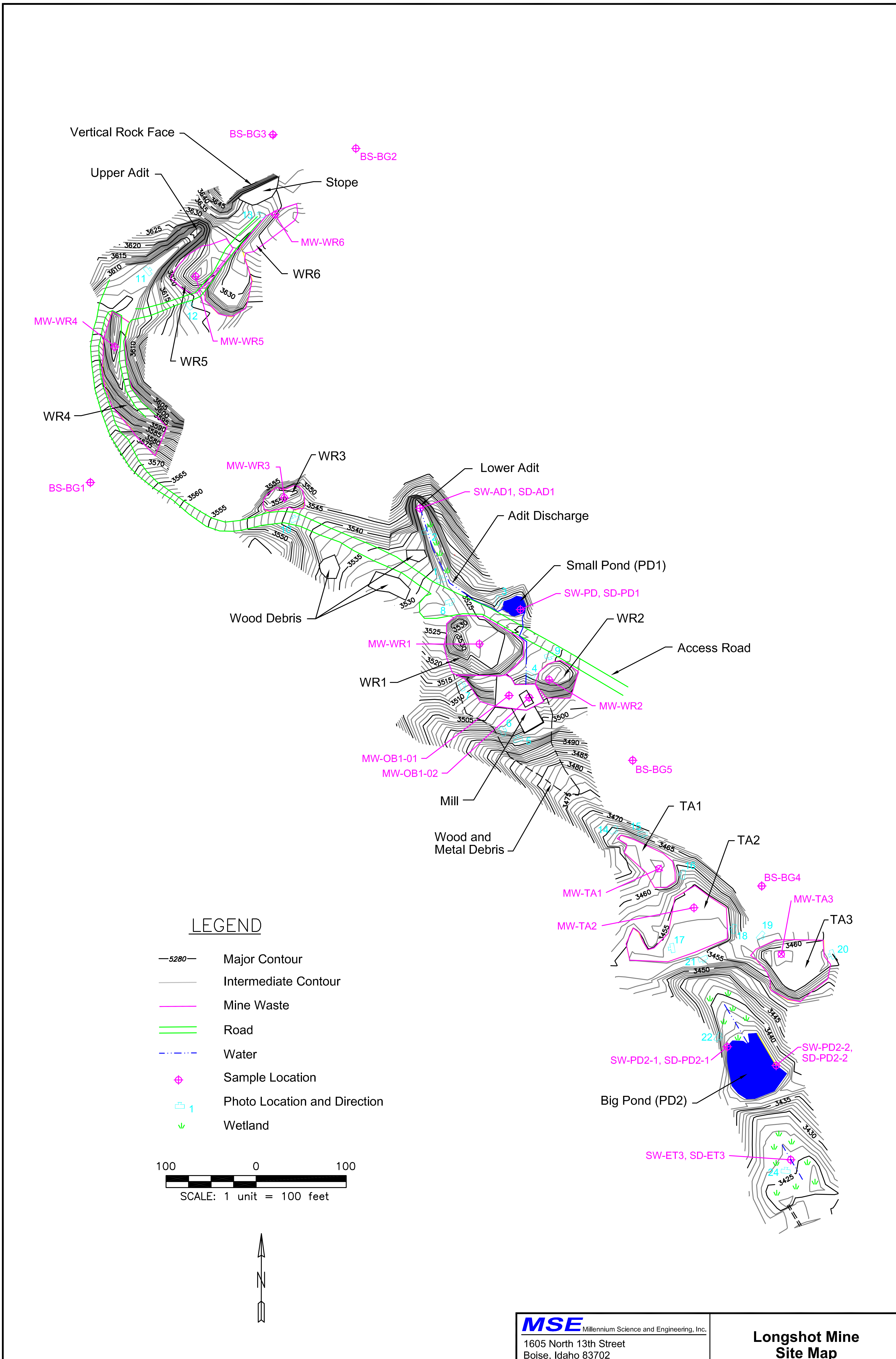
# SITE LOCATION MAP

**LONGSHOT MINE**
**COLVILLE NATIONAL FOREST**
**WASHINGTON**

| | | | |
|---|---|---|---|
| B2473B | 9-9-05 | MSE | FIGURE 2 |

:MSE\2473\2473B_F2 9.9.05




Base Map Source: RFK Land Surveying, 2004

| MSE Millennium Science and Engineering, Inc. 1605 North 13th Street Boise, Idaho 83702 Phone: (208) 345-8292 | | **Longshot Mine Site Map** | |
|---|---|---|---|
| B2473B | Figure3.dwg | 11-4-05 | Figure 3 |

**TABLES**

**Table 1. XRF Screening Results**

| Location | | XRF Reading in mg/kg | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Reading | Description | Pb | Zn | As | Fe | Hg | Cr | Mn | Ni | Mo |
| X1 | Waste Rock Pile 2 near mill | 35.1 | 217 | <23 | 25400 | <25 | | | | |
| X2 | Ore bin above mill | 9040 | 2270 | 304 | 8290 | | | | | |
| X3 | Waste Rock Pile 3 near road | 121 | 838 | 58.5 | 27300 | | | | | |
| X4 | Background past stope | 213 | 488 | <42 | 19100 | | | | | |
| X5 | Background above stope | 23.8 | 86.9 | <18 | 17800 | | | | | |
| X6 | Background above stope face | 33.6 | 75.2 | <23 | 18800 | | | | | |
| X7 | Background above stope on cat cut | 39.4 | 81.4 | <26 | 16600 | | | | 466 | |
| X8 | Material/cut outside of main adit | <19 | 62.6 | <18 | 23500 | | | | | |
| X9 | Background above main adit | 30.8 | 119 | NR | 26000 | | | | | 9.1 |
| X10 | Along left side of road to upper adit | NR | 99.8 | NR | 41900 | | | 1520 | 1410 | |
| X11 | Waste rock pile 1, above mill | 589 | 826 | <81 | 19900 | | | | | |
| X12 | Push road by upper adit | 278 | 568 | <47 | 25800 | | | | | |
| X13 | Left side of road to stope | 744 | 1720 | 74.6 | 54800 | | 798 | | | 11.2 |
| X14 | Across from stope | 810 | 1030 | NR | 53500 | | 675 | | 852 | |
| X15 | Background uphill of main site | <20 | 114 | <18 | 13800 | | | | | |
| X16 | Waste rock pile 1, side in draw | 156 | 216 | NR | 30100 | | | | | |
| X17 | TA1 near mouth | 1310 | 1910 | <89 | 16300 | | | | | |
| X18 | TA1 near embankment | 2140 | 1400 | <87 | 19100 | | | | | |
| X19 | TA2 near embankment | 553 | 1410 | NR | 13200 | | | | | |
| X20 | TA2 near edge | 1270 | 1770 | <83 | 16200 | | | | 723 | |
| X21 | TA3 top center | 250 | 338 | NR | 15500 | | | 748 | | |

Notes:
Used Niton 700 XRF Analyzer
NR = No reading
mg/kg = Milligram per kilogram

**Table 2. Estimated Mine Waste Areas and Volumes**

| Mine Waste | Pile or Impoundment | Area ($ft^2$) | Volume ($yd^3$) |
|---|---|---|---|
| **Unprocessed Ore** | OB1 | 400 | 50 |
| | **Subtotal =** | **400** | **50** |
| **Waste Rock** | WR1 | 4,734 | 852 |
| | WR2 | 1,467 | 248 |
| | WR3 | 561 | 63 |
| | WR4 | 4,318 | 382 |
| | WR5 | 2,138 | 187 |
| | WR6 | 3,942 | 456 |
| | **Subtotal =** | **17,160** | **2,187** |
| **Tailings** | TA1 | 1,718 | 160 |
| | TA2 | 4,915 | 535 |
| | TA3 | 4,167 | 247 |
| | **Subtotal =** | **10,800** | **942** |
| | **TOTAL =** | **28,360 $ft^2$** | **3,179 $yd^3$** |

Notes:
$ft^2$ = square foot
$yd^3$ = cubic yard

**Table 3. Field Investigation Sample Summary**

| Medium | Description | Location | Number and Type of Samples |
|---|---|---|---|
| Mine Waste | Unprocessed ore grab samples from ore bin | OB1 | 2 Grab |
| | Waste Rock grab samples from each waste rock pile | WR1-6 | 6 Grab |
| | Composite samples from waste rock piles | WR1&2<br>WR5&6 | 2 Composite |
| | Tailings grab samples from each tailing impoundment | TA1-3 | 3 Grab |
| | Composite samples from tailings impoundments | TA1<br>TA2 | 2 Composite |
| Background Soil | Single grab sample from five different locations representative of background conditions | BG1-5 | 5 Grab |
| | Composite sample of subsamples from the five grab sample locations | BG1-5 | 1 Composite |
| Sediment | Composite samples of two subsamples from pool and riffle habitats at each stream surface water sample location. Composite samples of three subsamples collected from the adit discharge and each pond | SW-BG<br>MC1-2<br>ET2-4<br>AD1<br>PD1<br>PD2-1,2 | 10 Composite |
| Surface Water | Background seep in an adjacent ephemeral drainage | SD-BG | 1 Grab |
| | Adit discharge | AD1 | 1 Grab |
| | <u>Ephemeral tributary</u>:<br>(1) downstream of the large pond<br>(2) downstream of site<br>(3) immediately before South Fork Mill Creek | ET3<br>ET2<br>ET4 | 3 Grab |
| | <u>South Fork Mill Creek</u>:<br>(1) immediately upstream of tributary<br>(2) immediately downstream of tributary | MC1<br>MC2 | 2 Grab |
| | Small settling pond<br>Large pond | PD1<br>PD2-1,2 | 3 Grab |
| Pore Water | South Fork Mill Creek upstream and downstream of ephemeral tributary | MC1-2 | 2 Grab |
| Benthic Organisms | Two composite samples from each of the two surface water sample locations on South Fork Mill Creek | MC1-2 | 4 Composite |
| Quality Control | Mine waste field duplicate<br>Surface water field duplicate<br>Surface water field blank | TA1<br>AD1<br>BLANK | 3 Grab |

**Table 4. Surface Water Field Parameters and Flows**

| Location | ID | Temp (°C) | pH | EC (microS /cm) | DO (mg/L) | ORP (mV) | Flow (gpm) |
|---|---|---|---|---|---|---|---|
| Background seep | SW-BG | 12.52 | 7.72 | 0.286 | 9.3 | -371.4 | < 1 |
| Adit discharge | SW-AD1 | 8.68 | 8.02 | 0.301 | 12.31 | -359.1 | 6.7 |
| Small pond | SW-PD1 | 10.1 | 7.98 | 0.302 | 12.38 | -338.4 | NM |
| Big pond | SW-PD2 | 19.25 | 7.62 | 0.393 | 10.07 | -383.7 | NM |
| Seep below big pond | SW-ET3 | 15.61 | 7.61 | 0.355 | 11.27 | -359.3 | 4.9 |
| Downstream of site | SW-ET2 | 10.93 | 7.58 | 0.291 | 11.13 | -372.3 | 14.8 |
| Upstream of South Fork Mill Creek | SW-ET4 | 6.72 | 8.02 | 0.257 | 13.35 | -298.9 | 94.9 |
| South Fork Mill Creek (upstream) | SW-MC1 | 15.82 | 8.3 | 0.205 | 12.96[a] | -445.4 | NM |
| South Fork Mill Creek (downstream) | SW-MC2 | 16.43 | 8.21 | 0.205 | 13.39[a] | -435.9 | NM |

Notes:
All field parameters listed are based on a minimum of three averages
[a] YSI 556 MPS Multi-Parameter meter not properly calibrated
EC = Electrical conductivity
NM = No measurement
ORP = Oxygen reduction potential
°C = Degree Centigrade
gpm = Gallon per minute
microS/cm = Microseimen per centimeter
mg/L = Milligram per liter
mV = Milllivolt

**Table 5. Sample Analytical Summary**

| Medium | Description | Sample Type | Laboratory Analysis |
|---|---|---|---|
| Mine Waste | Unprocessed Ore | Grab | pH, TALM[a]+CN, ABA |
| | Waste Rock | Grab | pH, Metals[b]+CN |
| | | Composite | pH, Metals[b]+CN, ABA |
| | Tailings | Grab | pH, Metals[b]+CN |
| | | Composite | pH, Metals[b]+CN, ABA |
| Background Soil | Soil | Grab | pH, Metals[b]+CN |
| | | Composite | pH, ABA |
| Sediment | Sediment from Surface Water Sampling Locations | Composite | pH, Metals[b]+CN, TOC |
| Surface Water | Adit Discharge | Filtered | Dissolved TALM[a]; Hardness; As/Cr spec; Total Se, Cr |
| | | Unfiltered | Total As, Hg; CN, Sulfate |
| | Pond Water | Filtered | Dissolved TALM[a]; Hardness; As/Cr spec[c]; Total Se, Cr |
| | | Unfiltered | Total As, Hg; CN, Sulfate |
| | Ephemeral Tributary Seeps | Filtered | Dissolved TALM[a]; Hardness; Total Se, Cr |
| | | Unfiltered | Total As, Hg; CN, Sulfate |
| | South Fork Mill Creek | Filtered | Dissolved TALM[a]; Hardness; Total Se, Cr |
| | | Unfiltered | Total As, Hg; CN, Sulfate |
| Pore Water | South Fork Mill Creek | Filtered | Dissolved TALM[a]; Hardness; Total Se, Cr |
| | | Unfiltered | Total As, Hg; CN, Sulfate |
| Benthic Organisms | South Fork Mill Creek | Composite | Taxonomy, generally to genus or species |

Notes:
[a]Aluminum, silver, arsenic, barium, beryllium, calcium, cadmium, cobalt, copper, iron, mercury, potassium, magnesium, manganese, sodium, nickel, lead, antimony, selenium, thallium, vanadium, zinc.
[b]Aluminum, silver, arsenic, barium, calcium, cadmium, cobalt, copper, iron, mercury, potassium, magnesium, manganese, sodium, nickel, lead, antimony, vanadium, zinc.
[c]Arsenic and chromium speciation analyses performed on samples from the adit discharge sample (AD1) and the big pond (PD2).
As = arsenic, CN = cyanide, Cr = chromium, Hg = mercury, Se = selenium
ABA = Acid base accounting
TALM = Target Analyte List Metals

**Table 6. Background Soil Analytical Results Summary**

| Sample ID | pH | Analyte Concentration (mg/kg) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CN | Ca | K | Mg | Na | Ag | Al | As | Ba | Cd | Co | Cr | Cu | Fe | Hg | Mn | Ni | Pb | Sb | V | Zn |
| BS-BG1-G-01 | 7.37 | 0.25U | 3650 | 2120 | 3060 | 256 | 0.25U | 22400 | 4.30 | 249 | 0.83 | 6.63 | 20.8 | 13.2 | 17400 | 0.0165U | 1370 | 17.5 | 11.9 | 1.0U | 19.5 | 96.3 |
| BS-BG3-G-01 | 6.78 | 0.25U | 5570 | 1070 | 4370 | 202 | 0.25U | 27500 | 3.87 | 80.7 | 1.38 | 14.7 | 30.9 | 19.8 | 23700 | 0.0165U | 386 | 40.6 | 16.9 | 1.0U | 22.6 | 87.5 |
| BS-BG2-G-01 | 7.53 | 0.25U | 29100 | 2720 | 12300 | 359 | 3.43 | 25100 | 6.93 | 60.3 | 4.05 | 13.1 | 41.0 | 23.1 | 28300 | 0.0165U | 701 | 34.3 | 268 | 1.0U | 30.4 | 651 |
| BS-BG4-G-01 | 6.90 | 0.25U | 4530 | 2300 | 4280 | 382 | 0.25U | 26800 | 2.33 | 136 | 1.05 | 8.94 | 27.6 | 19.5 | 21400 | 0.0165U | 492 | 20.1 | 11.5 | 1.0U | 30.6 | 66.3 |
| BS-BG5-G-01 | 6.88 | 0.25U | 2990 | 3240 | 4760 | 152 | 0.25U | 22500 | 4.29 | 138 | 1.26 | 10.2 | 31.2 | 19.2 | 25200 | 0.0165U | 631 | 26.3 | 16.0 | 1.0U | 30.8 | 81.1 |
| min = | 6.78 | 0.25U | 2990 | 1070 | 3060 | 152 | 0.25U | 22400 | 2.33 | 60.3 | 0.83 | 6.63 | 20.8 | 13.2 | 17400 | 0.0165U | 386 | 17.5 | 11.5 | 1.0U | 19.5 | 66.3 |
| **MDC =** | **7.53** | **0.25U** | **29100** | **3240** | **12300** | **382** | **3.43** | **27500** | **6.93** | **249** | **4.05** | **14.7** | **41** | **23.1** | **28300** | **0.0165U** | **1370** | **40.6** | **268** | **1.0U** | **30.8** | **651** |
| avg = | 7.09 | | 9168 | 2290 | 5754 | 270 | | 24860 | 4.34 | 132.8 | 1.71 | 10.71 | 30.3 | 19.0 | 23200 | | 716 | 27.8 | 64.9 | | 26.8 | 196.4 |
| **95% UCL =** | | | **71278** | **3059** | **12819** | **365** | | **27117** | **5.92** | **202.7** | **3.74** | **13.79** | **37.3** | **22.4** | **27106** | | **1083** | **37.0** | **570** | | **692** | **538** |
| **Human Health Screening Criteria** | | | | | | | | | | | | | | | | | | | | | | |
| WDOE MTCA Method A Industrial Soil Cleanup Levels – Human Receptors (WDOE 2001b) | | | | | | | | | 20 | | 2 | | 19 | | | 2 | | | 1000 | | | |
| EPA Region IX Industrial Soil PRGs (EPA 2004a) | | | | | | | 5100 | 100000 | 1.6 | 67000 | 450 | 1900 | 450 | 41000 | 100000 | 310 | 19000 | 20000 | 800 | 410 | 1000 | 100000 |
| **Ecological Screening Criteria** | | | | | | | | | | | | | | | | | | | | | | |
| WDOE MTCA Ecological Indicator Soil Concentrations for Protection of Terrestrial Plants and Animals (WDOE 2001c) | | | | | | | 2p | 50p | 7w | 102w | 4p | 20p | 42p | 50s | | 0.1s | 1100p | 30p | 50p | 5p | 2p | 86p |
| EPA Ecological Soil Screening Levels (Eco-SSLs) (EPA 2005) | | | | | | | | | 37 | | 29 | 32 | 5 | 61 | | | | | | 21 | | 120 |
| ORNL Soil PRGS for Ecological Endpoints (Efroymson *et al.* 1997) | | | | | | | 2 | | 9.9 | 283 | 4 | 20 | 0.4 | 60 | | 0.0005 | | 30 | 40.5 | 5 | 2 | 8.5 |

Notes:
EPA = U.S. Environmental Protection Agency
MDC = Maximum detected concentration
MTCA = Model Toxics Control Act
ORNL = Oak Ridge National Laboratory
PRG = Preliminary remediation goal
UCL = Upper confidence limit
WDOE = Washington Department of Ecology
p = plant, s = soil, w = wildlife
U = Undetected, result = ½ reporting limit
mg/kg = Milligram per kilogram

## Table 7. Mine Waste Sample Analytical Results Summary

| | | | Analyte Concentration (mg/kg) | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID** | **pH** | **CN** | **Ca** | **K** | **Mg** | **Na** | **Ag** | **Al** | **As** | **Ba** | **Be** | **Cd** | **Co** | **Cr** | **Cu** | **Fe** | **Hg** | **Mn** | **Ni** | **Pb** | **Sb** | **Se** | **Tl** | **V** | **Z** |
| MW-OB1-G-02 | 7.94 | 0.025U | 156000 | 800 | 15700 | 125U | 147 | 5400 | 26.4 | 12.6 | 0.5U | 122 | 15.8 | 20.5 | 63.7 | 32500 | 0.165 | 1560 | 38.2 | 16000 | 43.0 | 1.5U | 1.0U | 9.59 | 23100 |
| MW-OB1-G-01 | 8.37 | 0.025U | 178000 | 125 | 99300 | 125U | 3.96 | 1330 | 9.01 | 23.3 | 0.5U | 14.8 | 1.5U | 6.90 | 21.9 | 8040 | 0.994 | 442 | 5.1 | 30000 | 5U | 1.5U | 1.0U | 48.7 | 2040 |
| MW-WR1-2-C-01 | 7.71 | 0.025U | 52400 | 3220 | 11400 | 340 | 0.62 | 23700 | 5.61 | 43.7 | | 2.05 | 14.5 | 37.6 | 40.2 | 27300 | 0.01665U | 515 | 31.3 | 34.8 | 1U | | | 39.3 | 136 |
| MW-WR5-6-01 | 7.53 | 0.025U | 18500 | 2060 | 12000 | 299 | 12.8 | 25500 | 36.9 | 47.7 | | 6.87 | 25.0 | 33.7 | 58.1 | 51000 | 0.01665U | 1220 | 44.4 | 1040 | 1U | | | 103 | 1630 |
| MW-WR1-G-01 | 8.02 | 0.025U | 80800 | 1430 | 16200 | 206 | 15.6 | 12500 | 15.4 | 22.2 | | 16.7 | 15.8 | 20.3 | 124 | 38400 | 0.01665U | 1510 | 24.1 | 1760 | 5.8 | | | 43.5 | 2610 |
| MW-WR2-G-01 | 7.84 | 0.025U | 110000 | 4150 | 7550 | 256 | 0.25U | 32700 | 3.50 | 17.0 | | 1.96 | 15.2 | 49.1 | 20.1 | 22700 | 0.01665U | 496 | 44.7 | 17.0 | 1U | | | 24.6 | 167 |
| MW-WR3-G-01 | 7.55 | 0.025U | 139000 | 823 | 18900 | 57 | 176 | 5140 | 27.1 | 12.4 | | 191 | 15.4 | 10.3 | 158 | 31400 | 0.285 | 1730 | 21.1 | 23200 | 88.5 | | | 9.89 | 39100 |
| MW-WR4-G-01 | 7.87 | 0.025U | 17500 | 3570 | 9110 | 582 | 2.57 | 30600 | 6.05 | 83.0 | | 4.71 | 16.8 | 46.4 | 22.4 | 32400 | 0.01665U | 724 | 37.5 | 299 | 1U | | | 39.8 | 677 |
| MW-WR5-G-01 | 7.8 | 0.025U | 22700 | 1820 | 13200 | 255 | 20.2 | 25400 | 20.9 | 46.3 | | 10.6 | 26.3 | 31.1 | 61.0 | 45500 | 0.01665U | 1320 | 38.2 | 1430 | 8.6 | | | 96.3 | 1980 |
| MW-WR6-G-01 | 7.84 | 0.025U | 13200 | 1090 | 13000 | 130 | 7.01 | 20200 | 41.0 | 26.3 | | 11.8 | 29.3 | 22.8 | 52.0 | 68100 | 0.01665U | 1620 | 34.3 | 1120 | 6.3 | | | 135 | 1640 |
| MW-TA1-C-01 | 7.73 | 0.025U | 127000 | 715 | 19600 | 125U | 19.7 | 4250 | 11.5 | 14.8 | 0.5U | 7.1 | 6.80 | 20.2 | 48.5 | 37100 | 0.0750 | 1670 | 32.9 | 3810 | 5U | 1.5U | 0.1U | 13.2 | 1470 |
| MW-TA2-C-01 | 8.17 | 1.42 | 151000 | 682 | 18200 | 125U | 30.9 | 2110 | 13.3 | 8.1 | 0.5U | 14.5 | 6.90 | 11.9 | 57.1 | 34700 | 0.0350 | 1680 | 23.2 | 1120 | 15.0 | 1.5U | 0.1U | 6.52 | 2080 |
| MW-TA1-G-01 | 7.68 | 0.025U | 189000 | 758 | 11200 | 25U | 8.37 | 2560 | 9.20 | 11.4 | | 9.04 | 4.28 | 9.70 | 77.9 | 15300 | 0.01665U | 908 | 10.1 | 892 | 3.4 | | | 4.88 | 1240 |
| MW-TA1-G-02 | 7.76 | 0.025U | 151000 | 693 | 18100 | 25U | 30.9 | 2710 | 13.8 | 7.70 | | 11.5 | 6.74 | 14.0 | 58.1 | 31400 | 0.01665U | 1640 | 17.0 | 1460 | 8.4 | | | 7.10 | 1120 |
| MW-TA2-G-01 | 7.80 | 0.025U | 128000 | 485 | 21600 | 25U | 15.6 | 1700 | 12.3 | 4.92 | | 11.5 | 7.87 | 8.87 | 85.1 | 45200 | 0.01665U | 2170 | 17.9 | 415 | 4.8 | | | 6.26 | 1390 |
| MW-TA3-G-01 | 7.86 | 0.025U | 342000 | 847 | 14000 | 25U | 7.27 | 2270 | 11.4 | 9.52 | | 5.96 | 4.62 | 8.94 | 25.1 | 22500 | 0.01665U | 1280 | 12.4 | 513 | 3.3 | | | 5.71 | 790 |
| SD-ET3-C-01 | 7.62 | 0.025U | 68900 | 558 | 24100 | 25U | 7.4 | 1930 | 5.6 | 11.2 | | 3.42 | 2.13 | 6.64 | 14.3 | 12000 | 0.132 | 782 | 5.3 | 4000 | 4.6 | | | 9.05 | 650 |
| min = | 7.53 | 0.025U | 13200 | 125 | 7550 | 25 | 0.25 | 1330 | 3.5 | 4.92 | 0.5U | 1.96 | 1.5 | 6.64 | 14.3 | 8040 | 0.01665 | 442 | 5.1 | 17 | 1U | 1.5U | 0.1U | 4.88 | 136 |
| **MDC =** | **8.37** | **1.42** | **342000** | **4150** | **99300** | **582** | **176** | **32700** | **41** | **83** | **0.5U** | **191** | **29.3** | **49.1** | **158** | **68100** | **0.994** | **2170** | **44.7** | **30000** | **88.5** | **1.5U** | **1U** | **135** | **39100** |
| avg = | 7.81 | 0.11 | 114412 | 1402 | 20186 | 162 | 29.8 | 11765 | 15.8 | 23.7 | | 26.2 | 12.64 | 21.1 | 58.1 | 32679 | 0.11 | 1251 | 25.7 | 5124 | 12.1 | | | 35.44 | 4813 |
| **95% UCL** | | | **166069** | **2125** | **43925** | **264** | **61.1** | **20607** | **22.2** | **35.2** | | **157** | **16.86** | **29.4** | **78.0** | **39780** | | **1476** | **32.2** | **13194** | **27.9** | | | **61.69** | **10860** |
| **Background Soil Concentrations:** | | | | | | | | | | | | | | | | | | | | | | | | | |
| 95%UCL = | | | 71278 | 3059 | 12819 | 365 | | 27117 | 5.92 | 202.7 | | 3.74 | 13.79 | 37.3 | 22.4 | 27106 | | 1083 | 37.0 | 570 | | | | 31.9 | 692 |
| **Human Health Screening Criteria:** | | | | | | | | | | | | | | | | | | | | | | | | | |
| WDOE MTCA Method A Industrial Soil Cleanup Levels – Human Receptors (WDOE 2001b) | | | | | | | | | 20 | | | 2 | | 19 | | | 2 | | | 1000 | | | | | |
| EPA Region IX Industrial Soil PRGs (EPA 2004a) | | | | | | | 5100 | 100000 | 1.6 | 67000 | 1900 | 450 | 1900 | 450 | 41000 | 100000 | 310 | 19000 | 20000 | 800 | 410 | 5100 | 67 | 1000 | 100000 |
| **Ecological Screening Criteria:** | | | | | | | | | | | | | | | | | | | | | | | | | |
| WDOE MTCA Ecological Indicator Soil Concentrations for Protection of Terrestrial Plants and Animals (WDOE 2001c) | | | | | | | 2p | 50p | 7w | 102w | 10p | 4p | 20p | 42p | 50s | | 0.1s | 1100p | 30p | 50p | 5p | 0.3w | 1p | 2p | 86p |
| EPA Ecological Soil Screening Levels (Eco-SSLs) (EPA 2005) | | | | | | | | | 37 | | | 29 | 32 | 5 | 61 | | | | | | 21 | | | | 120 |
| ORNL Soil PRGS for Ecological Endpoints (Efroymson *et al.* 1997) | | | | | | | 2 | | 9.9 | 283 | 10 | 4 | 20 | 0.4 | 60 | | 0.00051 | | 30 | 40.5 | 5 | 0.21 | 1 | 2 | 8.5 |

Notes:
EPA = U.S. Environmental Protection Agency; MDC = Maximum detected concentration; MTCA = Model Toxics Control Act; ORNL = Oak Ridge National Laboratory; PRG = Preliminary remediation goal; UCL = Upper confidence limit; WDOE = Washington Department of Ecology; p = plant; s = soil; w = wildlife; U = Undetected, result = ½ reporting limit; mg/kg = Milligram per kilogram

**Table 8. Acid Base Accounting Results Summary**

| Sample ID | AGP (t/1,000t)[a] | ANP (t/1,000t)[a] | NNP (t/1,000t)[a] | ANP/AGP Ratio | pH | Total Sulfur (%) |
|---|---|---|---|---|---|---|
| BS-BG-C-01 | 10.8 | 0.63 | 11.5 | 18 | 7.11 | 00.2 |
| MW-OB1-G-01 | <0.30 | 932 | 932 | 3,107 | 8.37 | <0.010 |
| MW-OB1-G-02 | 15.3 | 505 | 490 | 33 | 7.94 | 0.97 |
| MW-TA1-C-01 | <0.30 | 449 | 449 | 1,497 | 7.73 | <0.010 |
| MW-TA2-C-01 | 0.31 | 526 | 526 | 1,697 | 8.17 | <0.010 |
| MW-WR1-2-C-01 | 1.56 | 99.7 | 98.2 | 64 | 7.71 | 0.05 |
| MW-WR5-6-C-01 | 1.56 | 32.2 | 30.6 | 21 | 7.53 | 0.06 |

Notes:
[a]Tons of calcium carbonate ($CaCO_3$) per 1,000 tons of waste
AGP = Acid generating potential
ANP = Acid neutralizing potential
NNP = Net neutralizing potential

## Table 9. Sediment Sample Analytical Results Summary

| Sample ID | TOC (%) | TOT C (%) | pH | CN | Analyte Concentration (mg/kg) Ca | K | Mg | Na | Ag | Al | As | Ba | Cd | Co | Cr | Cu | Fe | Hg | Mn | Ni | Pb | Sb | V | Z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SD-BG1-C-01[a] | 3.83 | 4.16 | 6.96 | 0.25U | 5780 | 1260 | 2810 | 395 | 0.25U | 9010 | 0.84 | 30.2 | 0.34 | 3.47 | 13.6 | 10 | 8950 | 0.01665U | 237 | 9.5 | 5.01 | 1.0U | 12.9 | 18.1 |
| SD-MC1-C-01 | | | 6.69 | 0.25U | 3020 | 851 | 1910 | 158 | 0.25U | 6930 | 0.61 | 38.8 | 0.29 | 2.87 | 7.94 | 5.6 | 7630 | 0.0165U | 89.2 | 5.0 | 3.32 | 1.0U | 11.8 | 20.3 |
| SD-MC2-C-01 | | | 6.67 | 0.25U | 2870 | 867 | 1920 | 146 | 0.25U | 7960 | 1.29 | 51.1 | 0.30 | 3.04 | 9.56 | 7.3 | 7680 | 0.0165U | 93.6 | 6.6 | 5.21 | 1.0U | 12.2 | 25.0 |
| SD-ET2-C-01 | 6.94 | 7.24 | 7.33 | 0.25U | 3320 | 932 | 2190 | 158 | 0.25U | 6460 | 0.82 | 25.5 | 0.38 | 2.85 | 11.5 | 12.8 | 8930 | 0.01665U | 143 | 9.4 | 4.39 | 1.0U | 12.7 | 20.1 |
| SD-ET4-C-01 | 2.69 | 3.26 | 7.23 | 0.25U | 3560 | 1610 | 2560 | 207 | 0.25U | 8690 | 2.27 | 58.1 | 0.49 | 4.84 | 12.1 | 10.7 | 10900 | 0.01665U | 218 | 10.9 | 8.4 | 1.0U | 13.4 | 39.3 |
| SD-AD1-C-01 | 1.63 | 5.47 | 7.03 | 0.25U | 34700 | 1450 | 2220 | 166 | 0.25U | 9290 | 1.98 | 22.9 | 7.41 | 4.09 | 16.0 | 17.6 | 8360 | 0.01665U | 67.7 | 11.0 | 37.5 | 1.0U | 15.8 | 442 |
| SD-PD1-C-01 | 3.02 | 5.32 | 7.05 | 0.25U | 17900 | 1500 | 2290 | 126 | 0.25U | 9140 | 1.54 | 24.9 | 2.87 | 4.53 | 14.8 | 14.9 | 8360 | 0.01665U | 55.2 | 10.6 | 32.6 | 1.0U | 16.3 | 251 |
| SD-PD2-C-01 | 5.68 | 6.79 | 6.82 | 0.25U | 9680 | 1090 | 2850 | 166 | 0.95 | 7500 | 2.71 | 30.4 | 1.71 | 5.22 | 12.2 | 26.2 | 10500 | 0.0165U | 263 | 10.4 | 90.4 | 1.0U | 20.8 | 243 |
| SD-PD2-C-02 | 3.04 | 3.29 | 7.05 | 0.25U | 3710 | 907 | 1760 | 149 | 0.25U | 8280 | 1.39 | 32.9 | 0.51 | 4.06 | 9.74 | 22.8 | 7320 | 0.01665U | 55 | 7.7 | 12.4 | 1.0U | 14.8 | 59 |
| min (excluding BG) = | 1.63 | 3.26 | 6.67 | 0.25U | 2870 | 851 | 1760 | 126 | 0.25U | 6460 | 0.61 | 22.9 | 0.29 | 2.85 | 7.94 | 5.6 | 7320 | 0.0165U | 55 | 5 | 3.32 | 1.0U | 11.8 | 20.1 |
| **MDC (excluding) =** | **6.94** | **7.24** | **7.33** | **0.25U** | **34700** | **1610** | **2850** | **207** | **0.95** | **9290** | **2.71** | **58.1** | **7.41** | **5.22** | **16** | **26.2** | **10900** | **0.01665U** | **263** | **11** | **90.4** | **1U** | **20.8** | **442** |
| avg (excluding BG) = | 3.83 | 5.23 | 6.98 | | 9845 | 1151 | 2213 | 160 | | 8031 | 1.58 | 35.6 | 1.75 | 3.94 | 11.73 | 14.7 | 8710 | | 123 | 9.0 | 24.3 | | 14.7 | 137 |
| **95% UCL =** | | | | | **27296** | **1363** | **2455** | **175** | | **8714** | **2.05** | **44.2** | **4.50** | **4.56** | **13.54** | **19.6** | **9603** | | **176** | **10.5** | **59** | | **16.7** | **345** |
| **Ecological Screening Criteria:** | | | | | | | | | | | | | | | | | | | | | | | | |
| State of Washington Development of Freshwater Sediment Quality Values (WDOE 2002) - in development | | | | | | | | | 3.9 | | 5.9 | | 0.6 | | 26 | 16 | | 0.17 | | 16 | 31 | 35 | | 110 |
| State of Washington Development of Freshwater Sediment Quality Values (WDOE 2003a) - recommended only | | | | | | | | | 2.0 | | 20 | | 0.6 | | 95 | 80 | | 0.5 | | 60 | 335 | 0.4 | | 140 |
| EPA Threshold Effects Level (NOAA 1999) | | | | | | | | | | | 5.9 | | 0.596 | | 37.3 | 35.7 | | 0.174 | | 18 | 35 | | | 123 |
| EPA Probable Effects Level (NOAA 1999) | | | | | | | | | | | 17 | | 3.53 | | 90 | 197 | | 0.486 | | 35.9 | 91.3 | | | 315 |
| ORNL Preliminary Remediation Goals (PRGs) for Ecological Endpoints, Sediment (Efroymson *et al*. 1997) | | | | | | | | | 1.8 | | 42 | | 4.2 | | 159 | 77.7 | | 0.7 | | 38.5 | 110 | | | 270 |

Notes:
[a]Background sample
EPA = U.S. Environmental Protection Agency
MDC = Maximum detected concentration
NOAA = National Oceanic and Atmospheric Administration
ORNL = Oak Ridge National Laboratory
TOC = Total organic carbon
TOT C = Total carbon
UCL = Upper confidence limit
WDOE = Washington Department of Ecology
U = Undetected, result = ½ reporting limit
mg/kg = Milligram per kilogram

## Table 10.  Surface Water Sample Analytical Results Summary

| Sample ID | Analyte Concentration (mg/L)[b] | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Ag** | **Al** | **As** | **Ba** | **Be** | **Cd** | **Co** | **Cr** | **Cu** | **Fe** | **Hg** | **Mn** | **Ni** | **Pb** | **Sb** | **Se** | **Tl** | **V** | **Z** | **CN** |
| SW-BG1-F-01[a] | 0.0025U | 0.015U | 0.0015U | 0.0118 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.002U | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.005U | 0.005U |
| SW-MC1 | 0.0025U | 0.015U | 0.0015U | 0.0126 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.0046 | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.005U | 0.005U |
| SW-MC2 | 0.0025U | 0.015U | 0.0015U | 0.0125 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.0102 | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.005U | 0.005U |
| SW-ET4 | 0.0025U | 0.015U | 0.0015U | 0.0153 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.002U | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.005U | 0.005U |
| SW-ET2 | 0.0025U | 0.015U | 0.0015U | 0.0124 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.002U | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.005U | 0.005U |
| SW-ET3 | 0.0025U | 0.015U | 0.0015U | 0.0134 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.002U | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.005U | 0.005U |
| SW-PD2-01 | 0.0025U | 0.015U | 0.0015U | 0.0134 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.0133 | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.005U | 0.005U |
| SW-PD2-02 | 0.0025U | 0.015U | 0.0015U | 0.0132 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.0157 | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.005U | 0.005U |
| SW-PD1 | 0.0025U | 0.015U | 0.0015U | 0.0031 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.002U | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.038 | 0.005U |
| SW-AD1-01/02 | 0.0025U | 0.015U | 0.0015U | 0.0027 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.002U | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.066 | 0.005U |
| min (excluding BG) = | 0.0025U | 0.015U | 0.0015U | 0.0027 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.002U | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.005 | 0.005U |
| **MDC (excluding BG) =** | **0.0025U** | **0.015U** | **0.0015U** | **0.0153** | **0.001U** | **0.001U** | **0.003U** | **0.003U** | **0.005U** | **0.03U** | **0.0001U** | **0.0157** | **0.005U** | **0.0015U** | **0.01U** | **0.0015U** | **0.001U** | **0.0025U** | **0.066** | **0.005U** |
| avg (excluding BG) = | | | | 0.0101 | | | | | | | | 0.0056 | | | | | | | 0.0154 | |
| **95% UCL =** | | | | **0.0177** | | | | | | | | **0.0141** | | | | | | | **0.0880** | |
| 1- Wash HH | | | 0.000018 | | | | | | | | 0.00014 | | 0.61 | | 0.014 | 0.17 | 0.0017 | | | |
| 2- EPA HH | | | 0.000018 | 1 | 0.004 | 0.005 | | 0.1 | 1.3 | 0.3 | | 0.05 | 0.61 | 0.015 | 0.0056 | 0.17 | 0.0017 | | 7.4 | |
| 3- Wash Eco[c] | | | 0.19 | | | 0.00042 | | 0.01 | 0.0041 | | 0.000012 | | 0.0568 | 0.00066 | | 0.005 | | | 0.1045 | |
| 4- EPA Eco[c] | 0.00036 | 0.087 | 0.15 | 0.004 | 0.00066 | 0.00011 | | 0.011 | 0.0032 | 1 | 0.00077 | 0.12 | 0.0188 | 0.00066 | 0.03 | 0.005 | 0.012 | 0.02 | 0.12 | |
| 5 -ORNL Eco | 0.00036 | 0.087 | 0.0031 | 0.004 | 0.00066 | 0.00015 | 0.023 | 0.002 | 0.00023 | 0.158 | 0.00023 | 0.12 | 0.16 | 0.00066 | 0.03 | 0.00039 | 0.009 | 0.02 | 0.03 | |

| Sample ID | Analyte Concentration (mg/L) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Hard** | **Ca** | **K** | **Mg** | **Na** | **Eh** | **CN** | **S** | **Cr6** | **As3** | **As5** |
| SW-BG1-F-01 | 185 | 68.2 | 1.63 | 3.65 | 4.89 | 214 | 0.005U | 9.75 | | | |
| SW-MC1 | 116 | 41.1 | 1.65 | 3.36 | 3.36 | 205 | 0.005U | 4.50 | | | |
| SW-MC2 | 116 | 41.1 | 1.65 | 3.34 | 3.34 | 200 | 0.005U | 4.57 | | | |
| SW-ET4 | 201 | 66.9 | 1.78 | 8.28 | 3.64 | 399 | 0.005U | 47.4 | | | |
| SW-ET2 | 201 | 73.0 | 1.94 | 4.46 | 4.46 | 235 | 0.005U | 1.4 | | | |
| SW-ET3 | 222 | 78.8 | 1.59 | 6.00 | 3.37 | 207 | 0.005U | 1.4 | | | |
| SW-PD2-01 | 225 | 80.2 | 1.54 | 6.05 | 3.42 | 230 | 0.005U | 23.4 | 0.005U | | |
| SW-PD2-02 | 226 | 80.6 | 1.56 | 6.03 | 3.38 | 217 | 0.005U | 23.7 | | 0.0015U | 0.0015U |
| SW-PD1 | 217 | 80.6 | 1.5 | 3.77 | 3.45 | 224 | 0.005U | 29.8 | | | |
| SW-AD1-01/02 | 218 | 81.1 | 1.55 | 3.75 | 3.51 | 218 | 0.005U | 30.5 | 0.005U | 0.0015U | 0.0015U |
| min = | 116 | 41.1 | 1.5 | 3.34 | 3.34 | 200 | 0.005U | 4.5 | | | |
| **MDC =** | **226** | **81.1** | **1.94** | **8.28** | **4.46** | **399** | **0.005U** | **47.4** | | | |
| avg = | 194 | 69.3 | 1.64 | 5.00 | 3.55 | 237 | | 21.8 | | | |

Notes:
[a]Background sample
[b]Results are dissolved concentrations except for As, Hg, CN, and S; U = undetected, result = ½ reporting limit.
[b]Screening criteria for hardness dependent metals (Cd, Cu, Ni, Pb, Zn) are based on an average hardness of 196.
EPA = U.S. Environmental Protection Agency
MDC = Maximum detected concentration
ORNL = Oak Ridge National Laboratory
UCL = Upper confidence limit
mg/L = Milligram per liter
Wash = Washington
1-State of Washington ambient water quality criteria for protection of human health (WDOE 2001d)
2-EPA recommended chronic ambient water quality criteria for human consumption of water and fish (EPA 2004b)
3-State of Washington ambient water quality criteria for protection of aquatic life (WDOE 2003b)
4-EPA recommended chronic ambient water quality criteria for freshwater aquatic life (EPA 200b4); if none existed then used Tier II secondary chronic values (NOAA 1999)
5-ORNL Ecological screening levels for freshwater, lowest chronic value used (Suter and Tsao 1996)

## Table 11. Pore Water Sample Analytical Results Summary

| Sample ID | Analyte Concentration (mg/L)[a] | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ag | Al | As | Ba | Be | Cd | Co | Cr | Cu | Fe | Hg | Mn | Ni | Pb | Sb | Se | Tl | V | Z | CN |
| PW-MC1-01 | 0.0025U | 0.015U | 0.0015U | 0.027 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.075 | 0.0001U | 0.123 | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.005U | 0.005U |
| PW-MC2-01 | 0.0025U | 0.015U | 0.0015U | 0.013 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.007 | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.005U | 0.005U |
| min = | 0.0025U | 0.015U | 0.0015U | 0.013 | 0.001U | 0.001U | 0.003U | 0.003U | 0.005U | 0.03U | 0.0001U | 0.007 | 0.005U | 0.0015U | 0.01U | 0.0015U | 0.001U | 0.0025U | 0.005U | 0.005U |
| **MDC =** | **0.0025U** | **0.015U** | **0.0015U** | **0.0268** | **0.001U** | **0.001U** | **0.003U** | **0.003U** | **0.005U** | **0.075** | **0.0001U** | **0.123** | **0.005U** | **0.0015U** | **0.01U** | **0.0015U** | **0.001U** | **0.0025U** | **0.005U** | **0.005U** |
| avg = | | | | 0.0201 | | | | | | 0.053 | | 0.065 | | | | | | | | |
| 1- Wash HH | | | 0.000018 | | | | | | | | 0.00014 | | 0.61 | | 0.014 | 0.17 | 0.0017 | | | |
| 2- EPA HH | | | 0.000018 | 1 | 0.004 | 0.005 | | 0.1 | 1.3 | 0.3 | | 0.05 | 0.61 | 0.015 | 0.0056 | 0.17 | 0.0017 | | 7.4 | |
| 3- Wash Eco[b] | | | 0.19 | | | 0.00042 | | 0.01 | 0.0041 | | 0.000012 | | 0.0568 | 0.00066 | | 0.005 | | | 0.1045 | |
| 4- EPA Eco[b] | 0.00036 | 0.087 | 0.15 | 0.004 | 0.00066 | 0.00011 | | 0.011 | 0.0032 | 1 | 0.00077 | 0.12 | 0.0188 | 0.00066 | 0.03 | 0.005 | 0.012 | 0.02 | 0.12 | |
| 5 -ORNL Eco | 0.00036 | 0.087 | 0.0031 | 0.004 | 0.00066 | 0.00015 | 0.023 | 0.002 | 0.00023 | 0.158 | 0.00023 | 0.12 | 0.16 | 0.00066 | 0.03 | 0.00039 | 0.009 | 0.02 | 0.03 | |

| Sample ID | Analyte Concentration (mg/L) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Hard | Ca | K | Mg | Na | Eh | CN | S |
| PW-MC1-01 | 108 | 37.2 | 2.23 | 3.61 | 3.54 | 212 | 0.005U | 0.65 |
| PW-MC2-01 | 120 | 42.1 | 1.67 | 3.51 | 3.33 | 198 | 0.005U | 4.74 |
| Min = | 108 | 37.2 | 1.67 | 3.51 | 3.33 | 198 | | 0.65 |
| **MDC =** | **120** | **42.1** | **2.23** | **3.61** | **3.54** | **212** | | **4.74** |
| Avg = | 114 | 39.7 | 1.95 | 3.56 | 3.44 | 205 | | 2.70 |

Notes:
[a]Results are dissolved concentrations except for As, Hg, CN, and S; U = undetected, result = ½ reporting limit.
[b]Screening criteria for hardness dependent metals (Cd, Cu, Ni, Pb, Zn) are based on a hardness of 100.
EPA = U.S. Environmental Protection Agency
MDC = Maximum detected concentration
ORNL = Oak Ridge National Laboratory
mg/L = Milligram per liter
Wash = Washington
1-State of Washington ambient water quality criteria for protection of human health (WDOE 2001d)
2-EPA recommended chronic ambient water quality criteria for human consumption of water and fish (EPA 2004b)
3-State of Washington ambient water quality criteria for protection of aquatic life (WDOE 2003b)
4-EPA recommended chronic ambient water quality criteria for freshwater aquatic life (EPA 2004b); if none existed then used Tier II secondary chronic values (NOAA 1999)
5-ORNL Ecological screening levels for freshwater, lowest chronic value used (Suter and Tsao 1996)

**Table 12. Aquatic Survey Surface Water Field Parameters**

| Sample ID | Temp (°C) | EC (microS/cm) | DO (mg/L) | pH | Turbidity (NTUs) |
|---|---|---|---|---|---|
| Upstream Habitat Survey | 13.13 | 0.194 | 15.22[a] | 8.46 | 3.8 |
| Downstream Habitat Survey | 17.99 | 0.221 | 12.81 [a] | 8.32 | 2.5 |

Notes:
[a]YSI 556 MPS Multi-Parameter meter not properly calibrated
Temp = Temperature
EC = Electrical conductivity
DO = Dissolved oxygen
°C = Degrees Centigrade
mg/L = Milligram per liter
microS/cm = Microseimen per centimeter

**Table 13. Benthic Macroinvertebrate Results from Pool Habitat Samples**

| Sample ID | Total Insect Abundance | EPT[a] Abundance /Percent | Chironomidae Abundance/ Percent | Diptera Abundance /Percent | Odonata Abundance /Percent | Non Insects Abundance /Percent |
|---|---|---|---|---|---|---|
| 05MSE02 (upstream pool composite) | 2,174 | 505<br>23.2% | 1,196<br>55.02% | 178<br>8.18% | 16<br>0.74% | 259<br>11.9% |
| 05MSE04 (downstream pool composite) | 5,005 | 1,262<br>25.21% | 989<br>19.76% | 252<br>5.04% | 50<br>1.01% | 777<br>15.52% |

Notes:
[a]EPT Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies)

**Table 14. Benthic Macroinvertebrate Results from Riffle Habitat Samples**

| Sample ID | Total Insect Abundance | EPT[a] Abundance/ Percent | Chironomidae Abundance/ Percent | Diptera Abundance /Percent | Odonata Abundance /Percent | Non Insects Abundance /Percent |
|---|---|---|---|---|---|---|
| 05MSE01 (upstream pool composite) | 165 | 19<br>11.38% | 77<br>46.34% | 36<br>21.95% | 0<br>0% | 32<br>19.51% |
| 05MSE03 (downstream pool composite) | 2,077 | 378<br>18.2% | 1,127<br>54.24% | 268<br>12.9% | 18<br>0.88% | 220<br>10.6% |

Notes:
[a]EPT Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies)

**Table 15. BLM Risk Management Criteria Screening Summary**

| Media | Sb | As | Cd | Cu | Pb | Mn | Hg | Ni | Se | Ag | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Contaminant of Interest | | | | | | | | | | |
| **Human Receptors** | | | | | | | | | | | |
| Background Soil MDC (mg/kg) | 1U | 6.93 | 4.05 | 23.1 | 268 | 1370 | 0.0165U | 40.6 | | 3.43 | 651 |
| Mine Waste MDC (mg/kg) | 88.5 | 41 | 157.1 | 158 | 30000 | 2170 | 0.994 | 44.7 | 1.5U | 176 | 39100 |
| Camper RMC | 50 | 20 | 70 | 5000 | 1000 | 19000 | 40 | 2700 | 700 | 700 | 40000 |
| ATV Driver RMC | 750 | 300 | 950 | 70000 | 1000 | 250000 | 550 | 38000 | 9600 | 9600 | 550000 |
| Sediment MDC (mg/kg) | 1U | 2.71 | 7.41 | 26.2 | 90.4 | 263 | 0.0165U | 11 | | 0.95 | 442 |
| Camper RMC | 62 | 46 | 155 | 5745 | 1000 | 21679 | 46 | 3094 | 774 | 774 | 46455 |
| Surface Water MDC (mg/L) | 0.01U | 0.0015U | 0.001U | 0.005U | 0.0015U | 0.016 | 0.0001U | 0.005U | 0.0015U | 0.0025U | 0.066 |
| Camper RMC | 0.124 | 0.093 | 0.155 | 11.49 | 0.05 | 1.548 | 0.093 | 6.194 | 1.548 | 1.548 | 92.909 |
| **Ecological Receptors** | | | | | | | | | | | |
| Background Soil MDC (mg/kg) | 1U | 6.93 | 4.05 | 23.1 | 268 | 1370 | 0.0165U | 40.6 | | 3.43 | 651 |
| Mine Waste MDC (mg/kg) | 88.5 | 41 | 157.1 | 158 | 30000 | 2170 | 0.994 | 44.7 | 1.5U | 176 | 39100 |
| Deer Mouse RMC | | 230 | 7 | 640 | 142 | | 2 | | | | 419 |
| Mule Deer RMC | | 200 | 3 | 102 | 106 | | 9 | | | | 222 |
| Elk RMC | | 328 | 3 | 131 | 127 | | 11 | | | | 275 |
| Canada Goose RMC | | 61 | 2 | 161 | 34 | | 6 | | | | 271 |
| Robin RMC | | 4 | 0.3 | 7 | 6 | | 1 | | | | 43 |

Notes:

< RMC = low risk

1 to 10X RMC = moderate risk

10 to 100X RMC = high risk

> 100X RMC = extremely high risk

BLM = U.S. Bureau of Land Management

MDC = Maximum detected concentration

RMC = Risk management criteria

mg/kg = Milligram per kilogram; mg/L = milligram per liter

U = Undetected, result = ½ reporting limit

**Table 16. Human Health Contaminant of Potential Concern Summary**

| Contaminant of Potential Concern | Media | | | |
|---|---|---|---|---|
| | Mine Waste | Surface Water | Sediment | Multimedia |
| Arsenic | X | X | X | X |
| Lead | X | X | | X |

**Table 17. Human Health Exposure Point Concentration Summary**

| Contaminant of Potential Concern | Exposure Point Concentrations | | | | | |
|---|---|---|---|---|---|---|
| | RME | | | CTE | | |
| | Mine Waste (mg/kg) | Surface Water (mg/L) | Sediment (mg/kg) | Mine Waste (mg/kg) | Surface Water (mg/L) | Sediment (mg/kg) |
| Arsenic | 22.2 | 0.0015U | 2.1 | 16.1 | 0.0015U | 1.6 |
| Lead | 13,194 | 0.0015U | 59 | 5,371 | 0.0015U | 24.3 |

Notes:
CTE = Central tendency exposure
RME = Reasonable maximum exposure
U = Undetected, result = ½ reporting limit
mg/kg = Milligram per kilogram
mg/L = Milligram per liter

**Table 18. Human Health Hazard and Cancer Risk Summary**

| Receptor | Media | | | TOTAL | Acceptable Level |
|---|---|---|---|---|---|
| | Mine Waste | Sediment | Surface Water | | |
| | **RME Hazard Quotient** | | | | |
| Adult Recreationalist | 4.E-03 | 2.E-04 | 2.E-04 | 4.E-03 | 1.E+00 |
| Child Recreationalist | 1.E-01 | 3.E-03 | 4.E-04 | 1.E-01 | 1.E+00 |
| | **CTE Hazard Quotient** | | | | |
| Adult Recreationalist | 8.E-04 | 3.E-05 | 1.E-04 | 1.E-03 | 1.E+00 |
| Child Recreationalist | 1.E-02 | 3.E-04 | 2.E-04 | 1.E-02 | 1.E+00 |
| | **RME Cancer Risk** | | | | |
| Adult Recreationalist | 8.E-07 | 4.E-08 | 4.E-08 | 9.E-07 | 1.E-06 |
| Child Recreationalist | **4.E-06** | 1.E-07 | 1.E-08 | **4.E-06** | 1.E-06 |
| | **CTE Cancer Risk** | | | | |
| Adult Recreationalist | 5.E-08 | 2.E-09 | 6.E-09 | 6.E-08 | 1.E-06 |
| Child Recreationalist | 4.E-07 | 1.E-08 | 7.E-09 | 4.E-07 | 1.E-06 |

Notes:
CTE = Central tendency exposure
RME = Reasonable maximum exposure

**Table 19. Contaminant of Potential Ecological Concern Summary**

| CPEC | Mine Waste | Surface Water | Sediment |
|---|---|---|---|
| Aluminum | P, I, B | | |
| Antimony | P | | |
| Cadmium | P, I, B | | AL |
| Cobalt | I | | |
| Copper | I | | |
| Iron | I | | |
| Lead | P, I, B, M | | |
| Manganese | I | | |
| Silver | P, I | | |
| Vanadium | P, I | | |
| Zinc | P, I, B, M | | AL |

Notes:
CPECs identified based on lack of screening level values are not included in this summary
P – Plants; I – Invertebrates; B – Birds; M – Mammals; AL – Aquatic Life
CPEC = Contaminant of potential ecological concern

**Table 20. Summary of Human Health and Ecological Contaminants of Potential Concern**

| Metal | Mine Waste | | Surface Water | | Sediment | | Pore Water | |
|---|---|---|---|---|---|---|---|---|
| | HH COPC | ECO CPEC[a] | HH COPC | ECO CPEC[a] | HH COPC | ECO CPEC[a] | HH COPC | ECO CPEC[a] |
| Aluminum | | X | | | | | | |
| Antimony | | X | | | | | | |
| Arsenic | X | | X | | X | | | |
| Cadmium | | X | | | | X | | |
| Cobalt | | X | | | | | | |
| Copper | | X | | | | | | |
| Iron | | X | | | | | | |
| Lead | X | X | X | | | | | |
| Manganese | | X | | | | | | |
| Silver | | X | | | | | | |
| Vanadium | | X | | | | | | |
| Zinc | | X | | | | X | | |

Notes:
[a]CPECs identified based on lack of screening level values are not included in this summary
COPC = Contaminant of potential concern
CPEC = Contaminant of potential ecological concern
HH = Human health
ECO = Ecological

**LONGSHOT MINE SITE INSPECTION**

**APPENDIX A**

**STREAMLINED**
**HUMAN HEALTH RISK ASSESSMENT**

## 1.0 INTRODUCTION

This streamlined human health risk assessment (HHRA) was prepared to evaluate risks associated with exposure to mining-related contaminants at the Longshot Mine, near Colville, Washington. The HHRA incorporates analytical data and other information gathered during the Site Inspection (SI) by Millennium Science and Engineering, Inc. (MSE).
The HHRA was prepared in general accordance with U.S. Environmental Protection Agency's (EPA's) *"Risk Assessment Guidance for Superfund (RAGS), Volumes 1 and 2"* (1991). This report summarizes the risk assessment methodology, assumptions, and estimated potential risks to human receptors, and is organized into the following sections:

- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Analysis
- Summary of Risks

Summary tables are presented throughout the text and risk calculations tables are provided in Attachment A.

## 2.0 EXPOSURE ASSESSMENT

Objectives of the exposure assessment are to: (1) identify potentially exposed populations and exposure pathways, (2) identify contaminants of potential concern (COPCs) at the site, (3) and estimate exposures to receptors. For the purposes of this risk assessment, both reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios were evaluated. The RME scenario is intended to be a very conservative estimate of potential exposure at the site while the CTE scenario is typically more realistic. The following sections discuss the conceptual site model (CSM), potentially exposed populations, potentially complete exposure routes, a summary of existing data, COPC screening and identification, exposure concentrations and factors, and the calculated daily intake rates.

### 2.1 Conceptual Site Model

A CSM provides the framework for assessing risk by identifying the contaminant sources, transport mechanisms, and potential exposure pathways, exposure routes, and receptors. A human health CSM identifies:

- The environmental setting and contaminants known or suspected to exist at the site
- Contaminant fate and transport mechanisms that might exist at the site
- Mechanisms of toxicity associated with contaminants and potential receptors
- Complete exposure pathways that might exist at the site
- Potential exposed populations

The human health CSM developed for the Longshot Mine based on existing data and the current and likely future conditions at the site is shown in Figure A.1.

## 2.2 Potentially Exposed Populations

The Longshot Mine is in a remote location with limited human access. There are no developed recreational areas near the site; however, hikers or hunters may occasionally traverse the site. Future uses of the site are expected to remain the same as current uses and may include mining, and recreational activities such as hiking and hunting. Residential development of the site is believed to be unlikely. Therefore, the risk of long-term exposure to contaminants at the site is considered low.

The primary exposed populations at the site and evaluated in the Longshot Mine HHRA are:

- Recreationalist – Adult Receptor
- Recreationalist – Child Receptor

## 2.3 Potentially Complete Exposure Routes

Based on the potentially exposed populations, exposure pathways evaluated in the Longshot Mine HHRA include:

- Incidental ingestion of mine waste (tailings and waste rock) and sediment
- Incidental Ingestion of surface water
- Dermal contact with mine waste, surface water, and sediment
- Inhalation of mine waste particulates

Other potentially complete pathways were qualitatively considered but not quantified, including fish tissue ingestion, groundwater ingestion, and plant ingestion.

There was no flow in the ephemeral tributary during the SI field investigation and no evidence of viable fish habitat within 1 mile downstream of the site. Additionally, no fish were observed in either pond on site. Although recreational fishing may occur on South Fork Mill Creek, the stream is more than 1 mile from the site and there are no obvious impacts from the site. Therefore, ingestion of fish tissue was determined to be an insignificant exposure pathway at the site. There is no current groundwater use at the site. The location of the nearest well is uncertain because of conflicting information in the water well report, but may be within 1 mile; however, this location is in a separate drainage and should not be hydraulically connected to the site. No palatable species of plants were observed at the site and it's unlikely that the site will be used for agricultural cultivation; therefore, plant ingestion was determined to be an insignificant pathway at the site.

## 2.4 Data Summary

Analytical data used in the HHRA consisted of results of background soil, mine waste (tailings and waste rock), surface water, pore water, and sediment samples collected by MSE during the SI field investigation. A total of 50 samples were collected, including 6 background soil samples, 15 mine waste samples, 10 sediment samples, 10 surface water samples, 2 pore water samples, 4 benthic macroinvertebrate samples, 1 field blank, and 2 field duplicates. Because there was no flow in the ephemeral tributary, the background surface water and sediment samples were limited to a single sample from a seep located in a separate drainage near the site.

Compounds analyzed for but not detected were reported at the laboratory reporting limit. For determining average concentrations and 95 percent upper confidence limits ($UCL_{95s}$), samples with undetected concentrations were conservatively included at concentrations equal to ½ the laboratory reporting limit.

## 2.5 Identification of Contaminants of Potential Concern

COPCs are compounds detected at the site that exceed risk-based screening levels and are used in the HHRA to evaluate potential risk to human receptors. COPCs are selected on the basis of frequency of detection, comparison to background concentrations, and potential toxicity. In accordance with EPA guidance, analytical data collected from the site were pre-screened to identify the COPCs based on the following criteria:

> **Frequency of Detection** – Compounds detected in less than 5 percent of the samples site-wide for a given media were eliminated from further screening.
>
> **Comparison with Background Concentrations** – Compounds with maximum detected concentrations (MDCs) below background levels were eliminated from further screening. Compounds in mine waste were compared to $UCL_{95}$ concentrations in the background soil samples. When calculating the background $UCL_{95}$ concentrations, if the computed $UCL_{95}$ exceeded the background MDC, the MDC was used in place of the $UCL_{95}$. For surface water and sediment, only a single background sample was collected and represented the background concentrations. For pore water, only two samples were collected; the upstream sample was considered background and the downstream sample concentrations were simply compared to the upstream concentrations.
>
> **Concentration-risk Screening** – MDCs of the remaining compounds were compared with EPA Region IX Preliminary Remediation Goals (PRGs). Because of the remoteness of the site and limited public access, Industrial Soil PRGs were used for mine waste and sediment, and EPA Region IX Tap Water PRGs were used for surface water (EPA 2004a). The screening also was conducted to evaluate potential cumulative effects of individual compounds across multiple media, as well as multiple compounds within each media and across multiple media. Compounds without PRGs, such as lead, were retained as COPCs for a qualitative evaluation and are discussed where appropriate, and in the uncertainty analysis in Section 5.

Surface water sample results were also compared with WDOE ambient water quality criteria for protection of human health (WAC173-340). No detected metals exceeded WDOE criteria; however, the laboratory reporting limit for arsenic exceeded WDOE criteria. Therefore, arsenic was retained as a COPC in surface water.

Background soil and mine waste sample results were also compared to WDOE Model Toxics Control Act (MTCA) Method A Industrial Soil Cleanup Levels (WAC 173-340, Table 745-1). Metals exceeding the soil cleanup levels included arsenic, cadmium, chromium, and lead. However, the MTCA soil cleanup levels for cadmium and chromium were developed based on protection of groundwater, which is not considered to be a complete pathway at the site. In addition, the chromium exceedance is conservatively based on the chromium VI cleanup level (19 milligram per kilogram [mg/kg]) rather than chromium III (2,000 mg/kg). The MDC for total chromium in mine waste was 49.1 mg/kg, which, although above the chromium IV cleanup level, is well below the chromium III cleanup level. Therefore, no additional COPCs were selected based on the comparison with MTCA soil cleanup levels.

Iron, calcium, magnesium, potassium, and sodium were screened out as essential nutrients. Based on results of the COPC screening process, the compounds presented in Table A.1 were identified as COPCs for the Longshot Mine HHRA.

**Table A.1. Human Health Contaminants of Potential Concern**

| Contaminant of Potential Concern | Media | | | |
|---|---|---|---|---|
| | Mine Waste | Surface Water | Sediment | Multimedia |
| Arsenic | X | X | X | X |
| Lead | X | X | | X |

## 2.6 Exposure Point Concentrations

Exposure point concentrations (EPCs) were developed from site-specific data and represent the concentration of each COPC that a receptor will potentially contact during the exposure period. Because of the uncertainty associated with estimating the true average concentration at a site, $UCL_{95s}$ were used for the RME EPC. The $UCL_{95s}$ were calculated using EPA's PROUCL statistical program. The program computes UCLs for each data set using several methods and recommends one based on the data distribution. However, data sets with fewer than 10 data samples can provide statistically unreliable estimates of the true average and may occasionally exceed the MDC. In those instances, the MDC was used. For the CTE scenario, the arithmetic mean concentration was used as the EPC for all media in accordance with EPA guidance. The EPCs used in the Longshot Mine HHRA are summarized in Table A.2.

**Table A.2. Exposure Point Concentration Summary**

| Analyte | Exposure Point Concentration | | | | | |
|---|---|---|---|---|---|---|
| | RME | | | CTE | | |
| | Mine Waste (mg/kg) | Surface Water (mg/L) | Sediment (mg/kg) | Mine Waste (mg/kg) | Surface Water (mg/L) | Sediment (mg/kg) |
| Arsenic | 22.7 | 0.0015U | 2.1 | 16.1 | 0.0015U | 1.6 |
| Lead | 13,194 | 0.0015U | 59 | 5,371 | 0.0015U | 24 |

Notes:
CTE = central tendency exposure
RME = reasonable maximum exposure
U = Not detected; value = ½ reporting limit
mg/kg = Milligram per kilogram
mg/L = Milligram per liter

## 2.7 Exposure Factors and Assumptions

Exposure factors (EFs) are variables that are combined with EPCs to calculate contaminant exposures for potential receptors (e.g., body weight, exposure frequency and duration, averaging time, intake rates, chemical bioavailability, etc.). EFs are typically derived from a combination of site-specific conditions and standard default values presented in risk assessment guidance documents. Site-specific values are typically limited to event frequencies. The EFs used in the Longshot Mine HHRA were developed in general accordance with EPA guidance and are summarized in Table A.3.

Because there are no developed recreational areas near the site and access is relatively difficult, recreational use is expected to be minimal. Therefore, the assumed exposure frequencies are based on limited recreational use by hunters or hikers.

## 3.0 TOXICITY ASSESSMENT

The objective of toxicity assessment is to identify specific toxicological properties of the COPCs for the purposes of evaluating the risk of exposure. Once site-specific COPCs have been identified, the toxicological properties are evaluated to determine the types and severity of potential health hazards associated with exposure to the COPCs. Toxicities vary significantly depending on carcinogenic or non-carcinogenic responses and exposure to some chemicals may result in both carcinogenic and non-carcinogenic effects.

**Table A.3. Exposure Factors Summary**

| Exposure Factor | Unit | Adult Recreationalist | | Child Recreationalist | | Source |
|---|---|---|---|---|---|---|
| | | CTE | RME | CTE | RME | |
| Body Weight | kg | 70 | 70 | 15 | 15 | EPA 1997 |
| Exposure Frequency: | | | | | | |
| Mine Waste | day/yr | 5 | 10 | 5 | 10 | Site specific |
| Sediment | day/yr | 5 | 10 | 5 | 10 | Site specific |
| Surface Water | day/yr | 5 | 10 | 5 | 10 | Site specific |
| Event Time: | | | | | | |
| Surface Water | hr/event | 2 | 2 | 2 | 2 | Site specific |
| Event Frequency | event/day | 1 | 1 | 1 | 1 | Site specific |
| Exposure Duration | year | 9 | 30 | 6 | 6 | EPA 1997 |
| Averaging Time: | | | | | | |
| Carcinogens | day | 25550 | 25550 | 25550 | 25550 | EPA 1989 |
| Noncarcinogens | day | 3285 | 10950 | 2190 | 2190 | EPA 1989 |
| Incidental Ingestion of Mine Waste | mg/day | 50 | 100 | 100 | 400 | EPA 1997 |
| Incidental Ingestion of Sediment | mg/day | 25 | 50 | 50 | 200 | EPA 1997 |
| Incidental Ingestion of Surface Water | L/day | 0.01 | 0.01 | 0.01 | 0.01 | EPA 1997 |
| Exposed Skin Surface Area | $cm^2$ | 5700 | 5700 | 2800 | 2800 | EPA 2004b |
| Inhalation Rate | $m^3$/day | 15.2 | 15.2 | 8.3 | 8.3 | EPA 1997 |
| Dermal Absorption Factors: | | | | | | |
| Inorganics | | 0.01-0.03 | 0.01-0.03 | 0.01-0.03 | 0.01-0.03 | Compound specific |
| Soil Adherence Factor: | | | | | | |
| Mine Waste | mg/$cm^2$-event | 0.08 | 0.08 | 0.3 | 1.00 | EPA 2004b |
| Sediment | mg/$cm^2$-event | 0.01 | 0.07 | 0.04 | 0.20 | EPA 2004b |
| Particulate Emission Factor | $m^3$/kg | 1.31E+09 | 1.31E+09 | 1.31E+09 | 1.31E+09 | EPA 2000 |

Notes:
EPA 1997. *"Exposure Factors Handbook."* Volumes I through III. EPA Office of Research and Development. August.
EPA 2000. *"Region IV Preliminary Remediation Goals."* 2000 Update. EPA. November.
EPA 2004b. *"Risk Assessment Guide for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment."* Volume I: Human Health Evaluation Model. EPA Office of Superfund Remediation and Technology Innovation. July.
CTE = central tendency exposure; RME = reasonable maximum exposure
$cm^2$ = Square centimeter; day/yr = Day per year; event/day = Event per day; hr/event = Hour per event; kg = Kilogram; $m^3$/day = Cubic meter per day; $m^3$/kg = Cubic meter per kilogram; $m^3$/hr = Cubic meter per hour; mg/day = Milligram per day; L/day = Liter per day; mg/$cm^2$-event = Milligram per square centimeter per event

## 3.1 Toxicity Values

Standard databases of toxicological properties have been developed from laboratory and epidemiological studies. The primary sources for toxicity data are EPA's Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Tables (HEAST). In accordance with WDOE guidance, the hierarchy for toxicity data used in this risk assessment was:

1) IRIS
2) HEAST

If toxicological properties for a specific chemical were in neither IRIS nor HEAST tables, additional sources such EPA's National Center for Environmental Risk Assessment (NCEA), Agency for Toxic Substances Disease Registry (ATSDR) Toxicological Profiles, or EPA Provisional Peer Reviewed Toxicity Values (PPRTVs) were used.

Most toxicity values are presented for both chronic and subchronic exposure periods. Subchronic exposures can vary from 2 weeks to 7 years (EPA 1991) and may be most representative of actual exposure times at the site. However, to be conservative, chronic toxicity values were used in this risk assessment. A summary of the non-carcinogenic and carcinogenic toxicological properties used in this risk assessment is provided in Tables A.4 and A.5, respectively.

### *3.1.1 Non-carcinogenic Toxicity*

The toxicity of non-carcinogenic COPCs is evaluated using reference doses (RfDs) developed from toxicological literature based on critical human and animal studies. When possible, human toxicological data are used; however, if human data are not available, a study using the most sensitive animal species is used. The RfDs used in this risk assessment are summarized in Table A.4.

### *3.1.2 Carcinogenic Toxicity*

Carcinogenic toxicity is not assumed to have a threshold concentration below which adverse effects do not occur. Therefore, carcinogenic risk from exposure to a COPC is expressed in terms of the probability that an exposed receptor will develop cancer over their lifetime. Contaminant-specific dose response curves are used to establish slope factors (SFs) that represent an upper-bound excess cancer risk from a lifetime exposure. Dose response curves for human carcinogens are developed from tumorgenic and laboratory studies; the SF is generated from the $UCL_{95}$ of the extrapolated dose curve using probabilistic methods and represents a conservative upper-bound estimate of the potential risk associated with exposure. The SFs used in this risk assessment are summarized in Table A.5.

### *3.1.3 Lead Toxicity*

Lead is classified as both a non-carcinogen and potential carcinogen; however, it is typically assessed as a non-carcinogen because those effects tend to occur at lower doses than those for carcinogenic effects. The most critical concern of exposure to lead is the potential for adverse neurological effects in young children.

**Table A.4. Noncarcinogenic Toxicological Properties**

| COPC | Oral RfD (mg/kg-day) | Source | Critical Effect | Uncertainty Factor | Inhalation RfD (mg/kg-day) | Critical Effect | Uncertainty Factor |
|---|---|---|---|---|---|---|---|
| Arsenic | 3.0E-04 | IRIS | Hyperpigmentation, keratosis, and possible vascular complications | 3 | -- | -- | -- |
| Lead | ND | ND | ND | ND | ND | ND | ND |

Notes:
mg/kg-day = Milligram per kilogram per day
COPC = Contaminant of potential concern
IRIS = Integrated Risk Information System (On-line database)
ND =No data
RfD = Reference dose

**Table A.5. Carcinogenic Toxicological Properties**

| COPC | Oral SF $(mg/kg\text{-}day)^{-1}$ | Source | Type of Cancer | Weight of Evidence | Inhalation SF $(mg/kg\text{-}day)^{-1}$ | Source | Type of Cancer | Weight of Evidence |
|---|---|---|---|---|---|---|---|---|
| Arsenic | 1.5E+00 | IRIS | Skin | A | 1.50E+01 | IRIS | Lung | A |

Notes:
mg/kg-day = Milligram per kilogram per day
A = Known human carcinogen
COPC = Contaminant of potential concern
IRIS = Integrated Risk Information System (On-line database)
SF = Slope factor

The EPA has not established RfDs and SFs for lead to assess hazard and risk from exposure. However, the EPA has developed a model to assess lead exposures to children and they provide suggested screening levels to limit risks from exposure to lead in soils and other media. Also, the BLM has developed Risk Management Criteria (RMC) for metals, including lead, at mining sites based on estimated risks to typical receptors (Ford 1996).

## 4.0 RISK CHARACTERIZATION

Potential human health impacts associated with exposure to COPCs at the Longshot Mine were evaluated by estimating both non-carcinogenic and carcinogenic effects. The following sections discuss the assessment of non-carcinogenic hazards, carcinogenic risks, and lead risk associated with exposure to COPCs at the site.

### 4.1 Non-carcinogenic Hazard Assessment

Non-carcinogenic hazards were evaluated by comparing estimated chronic daily intakes (CDIs) to EPA-established RfDs. The CDI represents the estimated daily exposure in milligrams per kilogram per day (mg/kg-day) to a contaminant at the site based on site-specific exposure factors and other parameters. RfDs are determined by the EPA and represent route-specific estimates of the safe dosage for each COPC over a lifetime of exposure. RfDs can be classified as chronic or subchronic depending on the length of exposure. Chronic RfDs were used in this risk assessment and represent the highest average daily exposure to a human receptor that will not cause adverse health effects during their lifetime.

CDIs were calculated for each pathway using the following equations:

Ingestion: $$CDI = \frac{CS \times IR \times EF \times ED \times CF}{BW \times AT}$$

Dermal Contact: $$CDI = \frac{CS \times SA \times SSAF \times DABS \times EF \times ED \times CF}{BW \times AT}$$

Inhalation: $$CDI = \frac{CS \times IN \times EF \times ED}{BW \times AT \times PEF}$$

Where:

*CS* = Contaminant concentration (milligram per kilogram [mg/kg] or milligram per liter [mg/L])

*IR* = Ingestion rate (milligram per day [mg/day])

*EF* = Exposure frequency (day per year)

*ED* = Exposure duration (year)

*CF* = Conversion factor (kg/mg or liter per cubic centimeter [L/cm$^3$])

*BW* = Body weight (kg)

*AT* = Averaging time (day)

*SA* = Skin surface area (square centimeter [cm$^2$])

*SSAF* = Soil to skin adherence factor (milligram per square centimeter per day [$mg/cm^2/day$])

*IN* = Inhalation rate (cubic meter per day [$m^3/day$])

*PEF* = Particulate emission factor (cubic meter per kilogram [$m^3/kg$])

Once the CDIs are calculated for all pathways, they are divided by the RfDs for each COPC to obtain a Hazard Quotient (HQ):

$$Noncarcinogenic\,HQ = \frac{CDI}{RfD}$$

Where:

*CDI* = Chronic daily intake; the estimated exposure over a given time

*RfD* = Reference dose; the exposure level above which represents potential adverse health effects

The individual HQ for each COPC in an exposure pathway is determined. If two or more contaminants have the same target organ or similar effects, their HQs are summed to determine a Hazard Index (HI). HQ or HI values greater than 1.E+00 indicate the potential for adverse health effects because the estimated intake exceeds the RfD. The individual HQs should only be summed if the contaminant has the same effect. For example, two contaminants that both have an effect on the liver should be summed into an HI. However, if one contaminant affects the liver and the other contaminant affect the CNS, the HQs should not be summed into an HI.

### 4.2 Carcinogenic Risk Assessment

The carcinogenic risk from exposure to a COPC is expressed in terms of the probability that an exposed receptor will develop cancer over their lifetime. Carcinogenic risks are estimated by multiplying the CDIs averaged over a lifetime of exposure by COPC-specific SFs developed by the EPA:

$$Carcinogenic\,Risk = \frac{CDI}{SF}$$

Where:

*CDI* = Chronic daily intake averaged over a lifetime; i.e., the estimated lifetime exposure at the site

*SF* = Slope factor; the upper-bound estimate of probability of cancer per unit of intake over a lifetime

The SF converts the contaminant intake to a risk of developing cancer from the exposure. SFs are chemical- and route-specific and represent an upper bound individual excess lifetime cancer risk.

The carcinogenic risk from each COPC in an exposure pathway is summed to determine the cumulative risk for each pathway and the cumulative risks from each pathway are summed to determine the overall site risk. According to EPA guidance, the acceptable excess cancer risk (ECR) from exposure to single and multiple carcinogens is less than or equal to 1.E-06 and 1.E-05, respectively.

### 4.3 Lead Risk Assessment

Risks from exposure to lead cannot be quantified using standard risk assessment algorithms because lead RfDs and SFs have not been established by the EPA. The EPA currently recommends two models for assessing lead risk based on the receptor age group. For children under the age of 7, the EPA recommends using the Integrated Exposure Uptake Biokinetic (IEUBK) model. The model focuses on younger children because they are considered to be the most sensitive receptors to the non-carcinogenic effects of inorganic lead. For adult exposures, the EPA developed the Adult Lead Methodology (ALM) model. Both models incorporate intake and uptake components of lead exposure and site-specific data to estimate blood lead concentrations which can indicate potential health risks. However, both models were developed to assess exposures under chronic, steady-state conditions such as a working environment, school, or residence. The models are not intended to be used for acute, short-term exposures such as those associated with occasional recreational use of a remote site. Specifically according to EPA guidance, the IEUBK model is not to be used for "exposure periods of less than 3 months, or in which higher exposure occurs less than once per week or varies irregularly" (EPA 2002). Similarly, the adult model (ALM) specifies a minimum exposure criteria of "one day per week for 90 days and no acute exposure scenarios" (EPA 2005).

Therefore, because exposures at the site are expected to be short-term and occasional, the lead exposure models were not used and lead risks were not quantitatively evaluated in this streamlined HHRA. However, lead risks were qualitatively evaluated by comparing lead concentrations at the site to EPA screening criteria and RMCs developed by the BLM. This process identified specific areas and media posing potential human health risks from exposure to lead at the Longshot Mine.

## 5.0 UNCERTAINTY ANALYSIS

The estimates of exposure, noncarcinogenic hazard, and carcinogenic risk presented in this risk assessment are subject to varying degrees of uncertainty from a variety of sources, including site data, exposure assessment, and risk characterization.

### 5.1 Site Data

The size of the data set, sample locations, and sample analyses can all contribute uncertainty to the risk assessment. In general, smaller data sets lend more statistical variability to estimates of contaminant concentrations and may over or under estimate the true mean or maximum concentration. Also, the development of background concentrations, particularly for surface water and sediment, was based on very limited information and may differ significantly from actual site conditions.

The intent of the sampling was to determine metals concentrations in areas of suspected contamination, such as mine waste piles, adit discharge, and ponds. Exposure doses based on the results of these non-random samples likely do not represent average conditions for the site and may significantly over estimate the true, site-wide, average exposure concentrations.

The analytical suite was limited to metals; risks from exposure to organics at this site were not characterized in this risk assessment.

### 5.2 Exposure Assessment

Many of the factors used to estimate exposure rates at the site are standard assumptions based on EPA risk assessment guidance values and may not accurately describe future site conditions or uses. The assumed receptors were limited to adult and child recreationalists. The recreational exposure frequencies are based on very limited use because of the absence of nearby developed recreational areas. However, the assumed duration of 30 years for the adult under the RME scenario may over estimate actual use since it is unlikely that a hunter or recreationalist will revisit the site for 30 consecutive years.

Recreational activities associated with the site (hiking and hunting) do not generally result in dermal contact or ingestion of sediment. Inclusion of these exposure pathways likely contributes additional conservatism to the risk assessment.

It is inherently assumed that future COPC concentrations will remain the same as current concentrations. In general, this typically over estimates COPC concentrations and the resulting exposure intakes.

### 5.3 Toxicity Assessment

Uncertainties are inherent in toxicity factors because of several factors, including statistical extrapolation, population variability, and limited biological and epidemiological studies. These uncertainties may contribute to under or over estimation of potential risks and hazards.

### 5.4 Risk Characterization

The standard algorithms used to calculate the contaminant intakes and associated health risks and hazards add uncertainty to the risk assessment. The algorithms assume the additivity of toxic effects for multiple contaminants and do not account for synergistic or antagonistic effects. Concurrent exposure to multiple pathways by a single receptor and the associated cumulative risks and hazards also is assumed which likely over estimates actual exposures. The algorithms also do not account for factors such as absorption or matrix effects.

### 5.5 Lead Risk

Because of the lack of established quantitative reference data for lead, potential health risks from exposure to lead at the site were not quantified. However, the potential risks were qualitatively evaluated by comparing lead concentrations in mine waste and surface water samples to suggested screening values and may or may not be representative of actual risks. In addition, the EPA screening value (Region IX Industrial Soil PRG) is based on a worker scenario with 250 days of exposure. Therefore, application of this screening level should provide a very conservative estimate of lead risk at the Longshot Mine site where the adult recreationalist exposure is based on 10 days per year under the RME scenario.

## 6.0 SUMMARY OF POTENTIAL RISKS

The estimated non-carcinogenic hazards and carcinogenic risks from exposure to COPCs at the Longshot Mine were compared with the EPA's acceptable hazard level of 1 (HI $\leq$ 1.E+00) and acceptable ECR from exposure to a single carcinogen of one per one million (ECR $\leq$ 1.E-06). The acceptable risk level for a single carcinogen was used because, although lead may be considered a carcinogen, arsenic was the only carcinogenic COPC for which risk levels were quantified.

The estimated non-carcinogenic hazards and carcinogenic risks from exposure to COPCs at the Longshot Mine are discussed in the following sections and summarized in Table A.6.

## 6.1 Non-carcinogenic Hazards

The results indicated very low non-carcinogenic hazards under both the CTE and RME scenarios. The total cumulative non-carcinogenic hazards were well below 1 for both receptors for all media and exposure pathways. The total cumulative HI to the adult recreationalist was 1.E-03 under the CTE scenario, and 4.E-03 under the RME scenario. The total cumulative HI to the child recreationalist was 1.E-02 under the CTE scenario, and 1.E-01 under the RME scenario. Incidental ingestion and dermal contact with mine wastes appear to be the most significant exposure pathways.

## 6.2 Carcinogenic Risks

The results indicated very low carcinogenic risks to the adult recreationalist under both the CTE and RME scenarios. The adult carcinogenic risks were below 1.E-06 for all media and exposure pathways. The total cumulative ECR to the adult recreationalist was 6.E-08 under the CTE scenario, and 9.E-07 under the RME scenario. For the child recreationist, the results indicated very low carcinogenic risk under the CTE scenario, and low risk under the RME scenario. The total cumulative ECR to the child recreationalist was 4.E-07 under the CTE scenario, and 4.E-06 under the RME scenario.

Incidental ingestion of and dermal contact with mine wastes are the most significant exposure pathways and contribute the majority of carcinogenic risk at the site. Inhalation of particulates from the mine waste contributed minimally (7.E-11 to 3.E-10) to the overall carcinogenic risk and, therefore is not considered a significant exposure pathway at the site. Similarly, incidental ingestion of and dermal contact with surface water at the site contribute minimal carcinogenic risk (7.E-09 to 4.E-08) and, therefore are not considered significant exposure pathways.

## 6.3 Lead Risks

Human health risks resulting from exposure to lead at the site were not quantified because (1) the EPA has not established quantitative reference data for lead, and (2) the current lead exposure models are based on chronic long-term exposures and are not intended for assessing risk from occasional short-term exposures. However, the potential risks were qualitatively evaluated by comparing lead concentrations in mine waste and surface water samples to establish suggested screening levels for the protection of human health.

The EPA has not specified a hazardous waste threshold value for total lead in soil and they have not established a drinking water maximum contaminant level (MCL) for lead; however, they suggest lead screening levels of 800 mg/kg for industrial soils and 15 microgram per liter (µg/L) for drinking water. Although lead was not detected in surface water at the site, 12 mine waste samples exceeded EPA's Region IX Industrial Soil PRG (800 mg/kg). In addition, 11 of the 12 mine waste samples also exceeded the BLM RMC of 1,000 mg/kg for lead concentrations in soil based on a camper receptor (Ford 1996). However, three of the mine waste samples had lead concentrations significantly higher than the remaining samples at more than 10 times the BLM RMC indicating high risk. If these three samples are removed, the average lead concentration in the mine waste decreases from 5,371 to 1,287 mg/kg, which represents moderate risk. Therefore, there appears to be significant but relatively isolated risks from exposure to lead in mine waste at the site, particularly to a child receptor.

**Table A.6. Human Health Hazard and Cancer Risk Summary**

| Exposure Pathway | Central Tendency Exposure | | | | Reasonable Maximum Exposure | | | |
|---|---|---|---|---|---|---|---|---|
| | Adult Recreationalist | | Child Recreationalist | | Adult Recreationalist | | Child Recreationalist | |
| | Non-carcinogenic HQ | Carcinogenic ECR | Non-carcinogenic HQ | Carcinogenic ECR | Non-carcinogenic HQ | Carcinogenic ECR | Non-carcinogenic HQ | Carcinogenic ECR |
| | **Mine Waste** | | | | **Mine Waste** | | | |
| Ingestion | 5.E-04 | 3.E-08 | 5.E-03 | 2.E-07 | 3.E-03 | 6.E-07 | 5.E-02 | **2.E-06** |
| Dermal | 3.E-04 | 2.E-08 | 5.E-03 | 2.E-07 | 1.E-03 | 2.E-07 | 5.E-02 | **2.E-06** |
| Inhalation | | 7.E-12 | | 1.E-11 | | 7.E-11 | | 3.E-11 |
| Subtotal = | 8.E-04 | 5.E-08 | 1.E-02 | 4.E-07 | 4.E-03 | 8.E-07 | 1.E-01 | **4.E-06** |
| | **Sediment** | | | | **Sediment** | | | |
| Ingestion | 3.E-05 | 1.E-09 | 2.E-04 | 9.E-09 | 1.E-04 | 3.E-08 | 3.E-03 | 1.E-07 |
| Dermal | 4.E-06 | 2.E-10 | 4.E-05 | 2.E-09 | 8.E-05 | 2.E-08 | 5.E-04 | 2.E-08 |
| Subtotal = | 3.E-05 | 2.E-09 | 3.E-04 | 1.E-08 | 2.E-04 | 4.E-08 | 3.E-03 | 1.E-07 |
| | **Surface Water** | | | | **Surface Water** | | | |
| Ingestion | 1.E-05 | 6.E-10 | 5.E-05 | 2.E-09 | 2.E-05 | 4.E-09 | 9.E-05 | 4.E-09 |
| Dermal | 9.E-05 | 5.E-09 | 1.E-04 | 6.E-09 | 2.E-04 | 3.E-08 | 3.E-04 | 1.E-08 |
| Subtotal = | 1.E-04 | 6.E-09 | 2.E-04 | 7.E-09 | 2.E-04 | 4.E-08 | 4.E-04 | 1.E-08 |
| **TOTAL =** | 1.E-03 | 6.E-08 | 1.E-02 | 4.E-07 | 4.E-03 | 9.E-07 | 1.E-01 | **4.E-06** |

Notes:
Bold values exceed EPA's recommended acceptable levels
CTE = central tendency exposure
RME = reasonable maximum exposure

## 7.0 REFERENCES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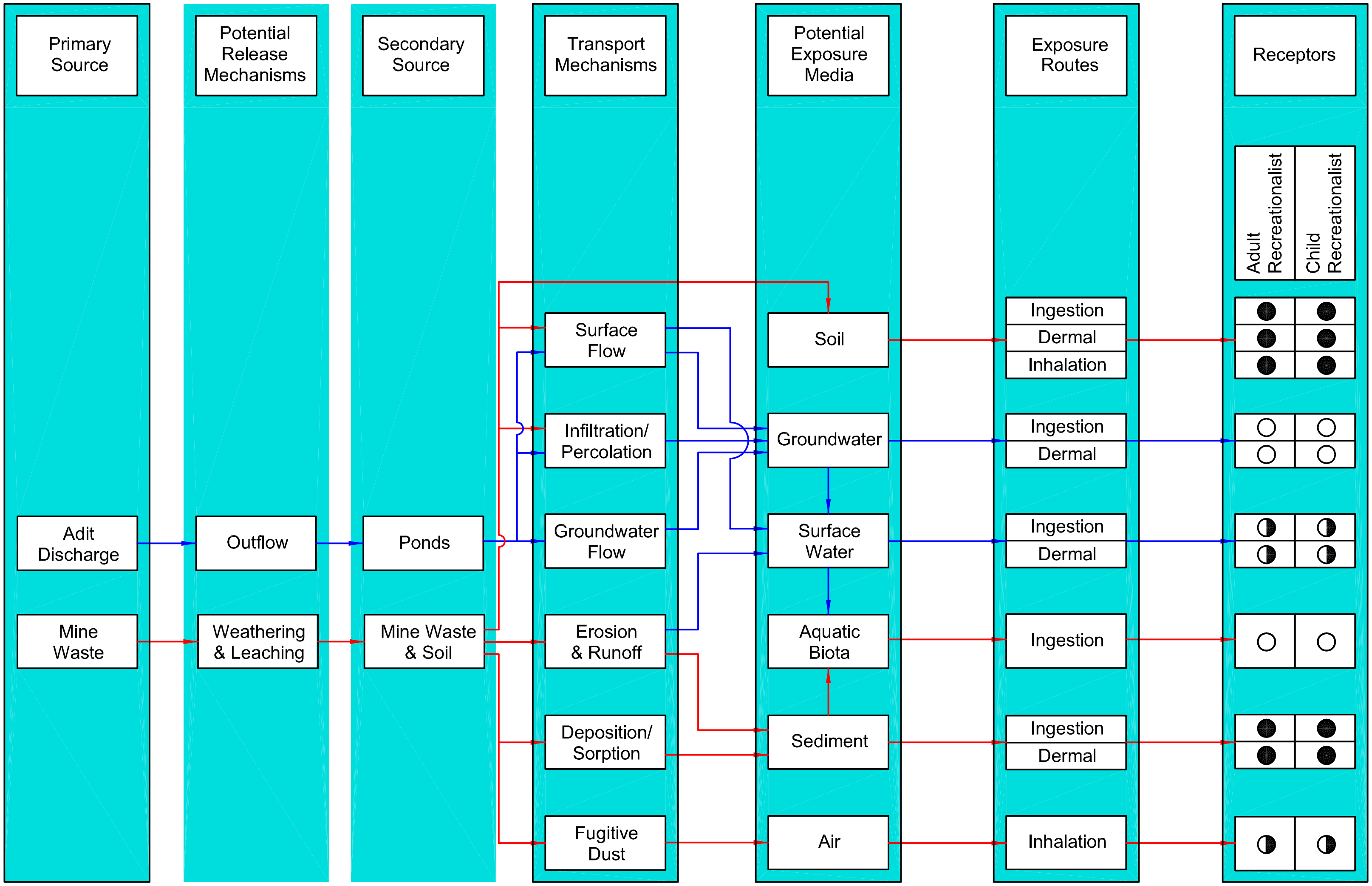


Legend

- ● Complete and potentially significant exposure pathway
- ◑ Potentially complete but insignificant exposure pathway
- ○ Incomplete exposure pathway

**MSE** Millenium Science and Engineering, Inc.
1605 North 13th Street
Boise, Idaho 83702
Phone: (208) 345-8292

**Human Health Conceptual Site Model**

| | | | |
|---|---|---|---|
| B2473B | 11-01-05 | HH CSM.dwg | FIGURE A.1 |

# Attachment A

# Risk Calculation Tables

**TABLE 1**
**Selection of Exposure Pathways**

| Scenario Timeframe | Media | Exposure Media | Exposure Point | Receptor Population | Receptor Age | Exposure Route | On-site/ Off-site | Type of Analysis | Rationale for Selection or Exlusion of Exposure Pathway |
|---|---|---|---|---|---|---|---|---|---|
| Current | Soil | Soil | Mine Waste | Recreationalist | Adult<br>Child | Ingestion<br>Dermal<br>Inhalation | On-Site | Quantitative | Current (Baseline) |
| | Sediment | Sediment | Adit Discharge, Ponds, and Seeps in Ephemeral Tributary | Recreationalist | Adult<br>Child | Ingestion<br>Dermal | On-Site | Quantitative | Current (Baseline) |
| | Surface Water | Surface Water | Adit Discharge, Ponds, and Seeps in Ephemeral Tributary | Recreationalist | Adult<br>Child | Ingestion<br>Dermal | On-Site | Quantitative | Current (Baseline) |

**TABLE 2**
**Contaminant of Potential Concern Screening**

**Mine Waste Screening**

| Metal | Max Conc ($C_{ij}$) | $UCL_{95}$ BG Conc | C>BG Retain as COPC? | EPA Reg 9 Industrial Soil PRGs ($PRG_{ij}$) | Units | $R_{ij}$ ($C_{ij}/PRG_j$) | C>PRG Retain as COPC? | $R_{ij}/R_j$ | Multi COI Retain as COPC? |
|---|---|---|---|---|---|---|---|---|---|
| Aluminum | 32700 | 27117 | **Yes** | 1.0E+05 | mg/kg | 3.27E-01 | No | 4.99E-03 | No |
| Antimony | 88.5 | 1.0 | **Yes** | 4.1E+02 | mg/kg | 2.16E-01 | No | 3.29E-03 | No |
| Arsenic | 41 | 5.9 | **Yes** | 1.6E+00 | mg/kg | 2.56E+01 | **Yes** | 3.91E-01 | **Yes** |
| Barium | 83 | 203 | No | 6.7E+04 | mg/kg | 1.24E-03 | No | 1.89E-05 | No |
| Beryllium | 0.5 | | No | 1.9E+03 | mg/kg | | No | | No |
| Cadmium | 191 | 3.74 | **Yes** | 4.5E+02 | mg/kg | 4.24E-01 | No | 6.47E-03 | No |
| Calcium | 342000 | 29100 | **Yes** | | mg/kg | | No[a] | | No |
| Chromium$_6$ | | | | | | | | | No |
| Chromium$_t$ | 49.1 | 37.3 | **Yes** | 4.5E+02 | mg/kg | 1.09E-01 | No | 1.66E-03 | No |
| Cobalt | 29.3 | 13.8 | **Yes** | 1.9E+03 | mg/kg | 1.54E-02 | No | 2.35E-04 | No |
| Copper | 158 | 22.4 | **Yes** | 4.1E+04 | mg/kg | 3.85E-03 | No | 5.88E-05 | No |
| Iron | 68100 | 27106 | **Yes** | 1.0E+05 | mg/kg | 6.81E-01 | No | 1.04E-02 | No |
| Lead | 30000 | 37 | **Yes** | 8.0E+02 | mg/kg | 3.75E+01 | **Yes** | 5.72E-01 | **Yes** |
| Magnesium | 99300 | 12300 | **Yes** | | mg/kg | | No[a] | | No |
| Manganese | 2170 | 1083 | **Yes** | 1.9E+04 | mg/kg | 1.14E-01 | No | 1.74E-03 | No |
| Mercury | 0.994 | 0.0165 | **Yes** | 3.1E+02 | mg/kg | 3.21E-03 | No | 4.89E-05 | No |
| Nickel | 44.7 | 37.0 | **Yes** | 2.0E+04 | mg/kg | 2.24E-03 | No | 3.41E-05 | No |
| Potassium | 4150 | 3059 | **Yes** | | mg/kg | | No[a] | | No |
| Selenium | 1.5 | | No | 5.1E+03 | mg/kg | | No | | No |
| Silver | 176 | 3.43 | **Yes** | 5.1E+03 | mg/kg | 3.45E-02 | No | 5.26E-04 | No |
| Sodium | 582 | 365 | **Yes** | | mg/kg | | No[a] | | No |
| Thallium | 1.0 | | No | 6.7E+01 | mg/kg | | No | | No |
| Vanadium | 135 | 30.8 | **Yes** | 1.0E+03 | mg/kg | 1.35E-01 | No | 2.06E-03 | No |
| Zinc | 39100 | 651 | **Yes** | 1.0E+05 | mg/kg | 3.91E-01 | No | 5.96E-03 | No |
| Cyanide | 1.42 | 0.025 | **Yes** | 1.2E+04 | mg/kg | 1.18E-04 | No | 1.80E-06 | No |
| **$R_j$ =** | | | | | | 66 | | | |
| **$N_{ij}$ =** | | | | | | 18 | | | |
| **$1/N_{ij}$ =** | | | | | | 0.06 | | | |

**Surface Water Screening**

| Metal | Max Conc ($C_{ij}$) | BG Conc[a] | C>BG Retain as COPC? | EPA Reg 9 Tap Water PRGs ($PRG_{ij}$) | Units | $R_{ij}$ ($C_{ij}/PRG_j$) | C>PRG Retain as COPC? | $R_{ij}/R_j$ | Multi COI Retain as COPC? |
|---|---|---|---|---|---|---|---|---|---|
| Aluminum | 0.015 | 0.015 | No | 36 | mg/L | 4.17E-04 | No | 1.20E-05 | No |
| Antimony | 0.01 | 0.01 | No | 0.015 | mg/L | 6.67E-01 | No | 1.92E-02 | No |
| Arsenic | 0.0015 | 0.0015 | No | 0.000045 | mg/L | 3.33E+01 | **Yes** | 9.61E-01 | No |
| Barium | 0.0153 | 0.0118 | **Yes** | 2.6 | mg/L | 5.88E-03 | No | 1.70E-04 | No |
| Beryllium | 0.001 | 0.001 | Yes | 0.073 | mg/L | 1.37E-02 | No | 3.95E-04 | No |
| Cadmium | 0.001 | 0.001 | No | 0.018 | mg/L | 5.56E-02 | No | 1.60E-03 | No |
| Calcium | 81.05 | 68.2 | **Yes** | | | | No[a] | | |
| Chromium$_6$ | 0.005 | | No | 0.11 | mg/L | 4.55E-02 | No | 1.31E-03 | No |
| Chromium$_t$ | 0.003 | 0.003 | No | | | | No | | No |
| Cobalt | 0.003 | 0.003 | No | 0.73 | mg/L | 4.11E-03 | No | 1.18E-04 | No |
| Copper | 0.005 | 0.005 | No | 1.5 | mg/L | 3.33E-03 | No | 9.61E-05 | No |
| Iron | 0.03 | 0.03 | No | 11 | mg/L | 2.73E-03 | No | 7.86E-05 | No |
| Lead | 0.0015 | 0.0015 | No | | | | **Yes** | | No |
| Magnesium | 8.28 | 3.65 | **Yes** | | | | No[a] | | |
| Manganese | 0.0157 | 0.002 | **Yes** | 0.88 | mg/L | 1.78E-02 | No | 5.14E-04 | No |
| Mercury | 0.0001 | 0.0001 | No | 0.011 | mg/L | 9.09E-03 | No | 2.62E-04 | No |
| Nickel | 0.005 | 0.005 | No | 0.73 | mg/L | 6.85E-03 | No | 1.97E-04 | No |
| Potassium | 1.94 | 1.63 | **Yes** | | | | No[a] | | |
| Selenium | 0.0015 | 0.0015 | No | 0.18 | mg/L | 8.33E-03 | No | 2.40E-04 | No |
| Silver | 0.0025 | 0.0025 | No | 0.18 | mg/L | 1.39E-02 | No | 4.00E-04 | No |
| Sodium | 4.46 | 4.89 | No | | | | No[a] | | |
| Thallium | 0.001 | 0.001 | No | 0.0024 | mg/L | 4.17E-01 | No | 1.20E-02 | No |
| Vanadium | 0.0025 | 0.0025 | No | 0.036 | mg/L | 6.94E-02 | No | 2.00E-03 | No |
| Zinc | 0.066 | 0.005 | **Yes** | 11 | mg/L | 6.00E-03 | No | 1.73E-04 | No |
| Cyanide | 0.005 | 0.005 | No | 0.73 | mg/L | 6.85E-03 | No | 1.97E-04 | No |
| **$R_j$ =** | | | | | | 34.69 | | | |
| **$N_{ij}$ =** | | | | | | 15 | | | |
| **$1/N_{ij}$ =** | | | | | | 0.07 | | | |

**Sediment Screening / Multimedia**

| Metal | Max Conc ($C_{ij}$) | BG Conc[a] | C>BG Retain as COPC? | EPA Reg 9 Industrial Soil PRGs ($PRG_{ij}$) | Units | $R_{ij}$ ($C_{ij}/PRG_j$) | C>PRG Retain as COPC? | $R_{ij}/R_j$ | Multi COI Retain as COPC? | Multimedia: Sum $R_{ij}$ | Multimedia: Multi media Retain as COPC? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Aluminum | 9290 | 9010 | **Yes** | 1.0E+05 | mg/kg | 9.29E-02 | No | 2.37E-02 | No | 0.42 | No |
| Antimony | 4.6 | 1.0 | **Yes** | 4.1E+02 | mg/kg | 1.12E-02 | No | 2.86E-03 | No | 0.89 | No |
| Arsenic | 5.6 | 0.84 | **Yes** | 1.6E+00 | mg/kg | 3.50E+00 | **Yes** | 8.92E-01 | **Yes** | 62.46 | **Yes** |
| Barium | 58.1 | 30 | **Yes** | 6.7E+04 | mg/kg | 8.67E-04 | No | 2.21E-04 | No | 0.01 | No |
| Beryllium | | | No | 1.9E+03 | mg/kg | | No | | No | 0.01 | No |
| Cadmium | 7.41 | 0.34 | **Yes** | 4.5E+02 | mg/kg | 1.65E-02 | No | 4.20E-03 | No | 0.50 | No |
| Calcium | 34700 | 5780 | **Yes** | | mg/kg | | No[a] | | | | No |
| Chromium$_6$ | | | No | | mg/kg | | | | | 0.05 | No |
| Chromium$_t$ | 16 | 13.6 | **Yes** | 4.5E+02 | mg/kg | 3.56E-02 | No | 9.07E-03 | No | 0.14 | No |
| Cobalt | 5.22 | 3.5 | **Yes** | 1.9E+03 | mg/kg | 2.75E-03 | No | 7.00E-04 | No | 0.02 | No |
| Copper | 26.2 | 10.0 | **Yes** | 4.1E+04 | mg/kg | 6.39E-04 | No | 1.63E-04 | No | 0.01 | No |
| Iron | 10900 | 8950 | **Yes** | 1.0E+05 | mg/kg | 1.09E-01 | No | 2.78E-02 | No | 0.79 | No |
| Lead | 90.4 | 5.0 | **Yes** | 8.0E+02 | mg/kg | 1.13E-01 | No | 2.88E-02 | No | 37.61 | **Yes** |
| Magnesium | 2850 | 2810 | **Yes** | | mg/kg | | No[a] | | | | No |
| Manganese | 263 | 237 | **Yes** | 1.9E+04 | mg/kg | 1.38E-02 | No | 3.53E-03 | No | 0.15 | No |
| Mercury | 0.0167 | 0.0167 | No | 3.1E+02 | mg/kg | 5.37E-05 | No | 1.37E-05 | No | 0.01 | No |
| Nickel | 11 | 9.5 | **Yes** | 2.0E+04 | mg/kg | 5.50E-04 | No | 1.40E-04 | No | 0.01 | No |
| Potassium | 1610 | 1260 | **Yes** | | mg/kg | | No[a] | | | | No |
| Selenium | | | No | 5.1E+03 | mg/kg | | No | | No | 0.01 | No |
| Silver | 0.95 | 0.25 | **Yes** | 5.1E+03 | mg/kg | 1.86E-04 | No | 4.75E-05 | No | 0.05 | No |
| Sodium | 207 | 395 | No | | mg/kg | | No[a] | | | | No |
| Thallium | | | No | 6.7E+01 | mg/kg | | No | | No | 0.42 | No |
| Vanadium | 20.8 | 12.9 | **Yes** | 1.0E+03 | mg/kg | 2.08E-02 | No | 5.30E-03 | No | 0.23 | No |
| Zinc | 442 | 18 | **Yes** | 1.0E+05 | mg/kg | 4.42E-03 | No | 1.13E-03 | No | 0.40 | No |
| Cyanide | 0.25 | 0.25 | No | 1.2E+04 | mg/kg | 2.08E-05 | No | | | 0.01 | No |
| **$R_j$ =** | | | | | | 3.922 | | | | | |
| **$N_{ij}$ =** | | | | | | 19 | | | | | |
| **$1/N_{ij}$ =** | | | | | | 0.0526 | | | | | |

Notes:
[a]Only one background sample.
BG = Background
COI = Contaminant of interest
Conc = Concentration
COPC = Contaminant of potential concern
EPA = U.S. Environmental Protection Agency
Max = Maximum
PRG = Preliminary remediation goal
mg/kg = Milligram per kilogram
mg/L = Milligram per liter
Shaded cells are non-detects; value = 1/2 reporting limit.

**TABLE 3**
**Exposure Factors Used for Daily Intake Calculations**

| Medium | Exposure Route | Parameter Code | Parameter Definition | Units | Recreationist - Adult RME Value | Recreationist - Adult CTE Value | Recreationist - Adult Reference | Recreationist - Child RME Value | Recreationist - Child CTE Value | Recreationist - Child Reference |
|---|---|---|---|---|---|---|---|---|---|---|
| All | All | BW | Body Weight | kg | 70 | 70 | EPA 1997 | 15 | 15 | EPA 1997 |
| | | AT-C | Averaging Time (Cancer) | day | 25,550 | 25,550 | EPA 1989 | 25,550 | 25,550 | EPA 1989 |
| | | AT-N | Averaging Time (Non-Cancer) | day | 10,950 | 3,285 | 365 x ED | 2,190 | 2,190 | 365 x ED |
| | | CF1 | Conversion Factor | 1 kg/mg | 1E-06 | 1E-06 | | 1E-06 | 1E-06 | |
| | | CF2 | Conversion Factor | L/cm$^3$ | 1E-03 | 1E-03 | | 1E-03 | 1E-03 | |
| Mine Waste | Ingestion | IR-S | Incidental Ingestion Rate of Soil | mg/day | 100 | 50 | EPA 1997 | 400 | 100 | EPA 1997 |
| | | EF | Exposure Frequency | day/year | 10 | 5 | (1) | 10 | 5 | (1) |
| | | ED | Exposure Duration | years | 30 | 9 | (1) | 6 | 6 | (1) |
| | Dermal | SA | Skin Surface Area Available for Contact | cm$^2$ | 6,900 | 5,200 | EPA 2004 | 5,000 | 4,500 | EPA 2004 |
| | | DABS | Dermal Absorption Factor [a] | -- | CS | CS | EPA 2004 | CS | CS | EPA 2004 |
| | | SSAF | Soil to Skin Adherence Factor | mg/cm$^2$/day | 0.08 | 0.08 | EPA 2004 | 1.00 | 0.3 | EPA 2004 |
| | Inhalation | IN | Inhalation Rate | m$^3$/day | 15.2 | 15.2 | EPA 1997 | 8.3 | 8.3 | EPA 1997 |
| | | PEF | Particulate Emission Factor | m$^3$/kg | 1.31E+09 | 1.31E+09 | EPA 2000 | 1.31E+09 | 1.31E+09 | EPA 2000 |
| Sediment | Ingestion | IR-S | Incidental Ingestion Rate of Sediment | mg/day | 50 | 25 | EPA 1997 | 200 | 50 | EPA 1997 |
| | | EF | Exposure Frequency | day/year | 10 | 5 | (1) | 10 | 5 | (1) |
| | | ED | Exposure Duration | years | 30 | 9 | (1) | 6 | 6 | (1) |
| | Dermal | SA | Skin Surface Area Available for Contact | cm$^2$ | 5,700 | 5,700 | EPA 2004 | 2,800 | 2,800 | EPA 2004 |
| | | DABS | Dermal Absorption Factor[a] | -- | CS | CS | EPA 2004 | CS | CS | EPA 2004 |
| | | SSAF | Soil to Skin Adherence Factor | mg/cm$^2$/day | 0.07 | 0.01 | EPA 2004 | 0.20 | 0.04 | EPA 2004 |
| Surface Water | Ingestion | IR-W | Incidental Ingestion Rate of Surface Water | L/day | 0.01 | 0.01 | EPA 1997 | 0.01 | 0.01 | EPA 1997 |
| | | EF | Exposure Frequency | day/year | 10 | 5 | (1) | 10 | 5 | (1) |
| | | ED | Exposure Duration | years | 30 | 9 | (1) | 6 | 6 | (1) |
| | Dermal | SA | Skin Surface Area Available for Contact | cm$^2$ | 18,000 | 18,000 | EPA 2004 | 6,600 | 6,600 | EPA 2004 |
| | | KP | Permeability Coefficient | cm/hr | 0.001 | 0.001 | EPA 2004 | 0.001 | 0.001 | EPA 2004 |
| | | ET | Exposure Time | hr/day | 2 | 2 | EPA 1997 | 2 | 2 | EPA 1997 |

Notes:

a Used EPA 2004 recommended value for arsenic of 0.03

(1) Site-specific assumed value

EPA 1997 "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -Fb, -Fc. August.

EPA 2000 "Region IV Preliminary Remediation Goals (PRGs) Table 2000 Update." November 3. On-line address: http://www.epa.gov/region9/waste/sfund/prg/whatsnew.htm.

EPA 2004 "Risk Assessment Guidance for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment." Volume I: Human Heath Evaluation Manual. Final. Office of Superfund Remediation and Technology Innovation. July.

## TABLE 4
## Exposure Point Concentration Summary

| Contaminant of Potential Concern | Media | Units | Artihmetic Mean | 95% UCL | Maximum Detected Concentration | Reasonable Maximum Exposure (RME) | | | Central Tendency Exposure (CTE) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Media EPC Value | Media EPC Statistic | Media EPC Rationale | Media EPC Value | Media EPC Statistic | Media EPC Rationale |
| Arsenic | Mine Waste | mg/kg | 16.1 | 22.2 | 41 | 22.2 | Appx. Gamma UCL | Gamma distribution | 16.1 | Mean | RAGS |
| | Sediment | mg/kg | 1.6 | 2.1 | 2.7 | 2.1 | Appx. Gamma UCL | Gamma distribution | 1.6 | Mean | RAGS |
| | Surface Water | mg/L | 0.0015 | 0.0015 | 0.0015 | 0.0015 | Non detect | -- | 0.0015 | -- | -- |

Notes:

EPC = Exposure point concentration

RAGS = U.S. Environmental Protection Agency (EPA), 1989. "Risk Assessment Guidance for Superfund (RAGS): Volume 1, Human Health Evaluation Manual" (Part A), No. 9285.701A. Office of Solid Waste and Emergency Response, Washington, DC.

UCL = Upper confidence level

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

Shaded cells are non-detects; value = 1/2 reporting limit.

**TABLE 5**
**Non-carcinogenic COPC Toxicity Data**

| Contaminant of Potential Concern | CAS Number | Chronic RfD (mg/kg-d) | | | Dermal Absorption Factor | Primary Target Organ | Combined Uncertainty/ Modifying Factors | Data Source |
|---|---|---|---|---|---|---|---|---|
| | | Oral | Dermal | Inhalation | | | | |
| Arsenic | 7440382 | 3.00E-04 | 1.23E-04 | NA | 0.03 | Skin, Nervous System, Cardiovascular System | 3/1 | IRIS, RAIS |

Notes:

IRIS = Integrated Risk Information System

NA = Not available

RAIS = Risk Assessment Information System

RfD = Reference dose

mg/kg-d = Milligram per kilogram per day

**TABLE 6**
**Carcinogenic COPC Toxicity Data**

| Contaminant of Potential Concern | CAS Number | Slope Factor (mg/kg-day) | | | Type of Cancer | Weight of Evidence/Cancer Guideline Description | Data Source |
|---|---|---|---|---|---|---|---|
| | | Oral | Dermal | Inhalation | | | |
| Arsenic | 7440382 | 1.50E+00 | 3.66E+00 | 1.51E+01 | Lung, Skin | A | IRIS |

Notes:

A = Known human carcinogen

IRIS = Integrated Risk Information System

mg/kg-d = Milligram per kilogram per day

**TABLE 7a**
**Summary of Non-carcinogenic Hazards**
**Adult Recreationalist**

| Media | COPC | Chronic Reference Dose (mg/kg-day) | | | CENTRAL TENDENCY EXPOSURE SCENARIO | | | | | | | | REASONABLE MAXIMUM EXPOSURE SCENARIO | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CTE EPC (mg/kg); (mg/L) | Intake (mg/kg-day) | | | Non-carcinogenic Hazard by Exposure Route | | | CTE Total Hazard | RME EPC (mg/kg); (mg/L) | Intake (mg/kg-day) | | | Non-carcinogenic Hazard by Exposure Route | | | RME Total Hazard |
| | | Oral | Dermal | Inhalation | | Ingestion | Dermal | Inhalation | Ingestion | Dermal | Inhalation | | | Ingestion | Dermal | Inhalation | Ingestion | Dermal | Inhalation | |
| Mine Waste | As | 3.0E-04 | 1.2E-04 | | 1.6E+01 | 1.6E-07 | 3.9E-08 | 3.7E-11 | 5.2E-04 | 3.2E-04 | | 8.4E-04 | 2.2E+01 | 8.7E-07 | 1.4E-07 | 1.0E-10 | 2.9E-03 | 1.2E-03 | | 4.1E-03 |
| | | | | | | | | **Mine Waste CTE Subtotal =** | **5.2E-04** | **3.2E-04** | | **8.4E-04** | | | | **Mine Waste RME Subtotal =** | **2.9E-03** | **1.2E-03** | | **4.1E-03** |
| Sediment | As | 3.0E-04 | 1.2E-04 | | 1.6E+00 | 7.7E-09 | 5.3E-10 | | 2.6E-05 | 4.3E-06 | | 3.0E-05 | 2.1E+00 | 4.0E-08 | 9.6E-09 | | 1.3E-04 | 7.8E-05 | | 2.1E-04 |
| | | | | | | | | **Sediment CTE Subtotal =** | **2.6E-05** | **4.3E-06** | | **3.0E-05** | | | | **Sediment RME Subtotal =** | **1.3E-04** | **7.8E-05** | | **2.1E-04** |
| Surface Water | As | 3.0E-04 | 1.2E-04 | | 1.5E-03 | 2.9E-09 | 1.1E-08 | | 9.8E-06 | 8.6E-05 | | 9.6E-05 | 1.5E-03 | 5.9E-09 | 2.1E-08 | | 2.0E-05 | 1.7E-04 | | 1.9E-04 |
| | | | | | | | | **Surface Water CTE Subtotal =** | **9.8E-06** | **8.6E-05** | | **9.6E-05** | | | | **Surface Water RME Subtotal =** | **2.0E-05** | **1.7E-04** | | **1.9E-04** |
| | | | | | | | | **Total CTE Non-carcinogenic Hazard =** | **5.6E-04** | **4.1E-04** | | **9.7E-04** | | | | **Total RME Non-carcinogenic Hazard =** | **3.1E-03** | **1.4E-03** | | **4.5E-03** |

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

RME = Reasonable maximum exposure

Shaded cells are non-detects; value = 1/2 reporting limit.

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

**TABLE 7b**
**Summary of Non-carcinogenic Hazards**
**Child Recreationalist**

| Media | COPC | Chronic Reference Dose (mg/kg-day) | | | CENTRAL TENDENCY EXPOSURE SCENARIO | | | | | | | | REASONABLE MAXIMUM EXPOSURE SCENARIO | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CTE EPC (mg/kg); (mg/L) | Intake (mg/kg-day) | | | Non-carcinogenic Hazard by Exposure Route | | | CTE Total Hazard | RME EPC (mg/kg); (mg/L) | Intake (mg/kg-day) | | | Non-carcinogenic Hazard by Exposure Route | | | RME Total Hazard |
| | | Oral | Dermal | Inhalation | | Ingestion | Dermal | Inhalation | Ingestion | Dermal | Inhalation | | | Ingestion | Dermal | Inhalation | Ingestion | Dermal | Inhalation | |
| Mine Waste | As | 3.0E-04 | 1.2E-04 | | 1.6E+01 | 1.5E-06 | 6.0E-07 | 9.3E-11 | 4.9E-03 | 4.8E-03 | | 9.7E-03 | 2.2E+01 | 1.6E-05 | 6.1E-06 | 2.6E-10 | 5.4E-02 | 5.0E-02 | | 1.0E-01 |
| | | | | | | | **Mine Waste CTE Subtotal =** | | **4.9E-03** | **4.8E-03** | | **9.7E-03** | | | **Mine Waste RME Subtotal =** | | **5.4E-02** | **5.0E-02** | | **1.0E-01** |
| Sediment | As | 3.0E-04 | 1.2E-04 | | 1.6E+00 | 7.2E-08 | 4.8E-09 | | 2.4E-04 | 3.9E-05 | | 2.8E-04 | 2.1E+00 | 7.5E-07 | 6.3E-08 | | 2.5E-03 | 5.1E-04 | | 3.0E-03 |
| | | | | | | | **Sediment CTE Subtotal =** | | **2.4E-04** | **3.9E-05** | | **2.8E-04** | | | **Sediment RME Subtotal =** | | **2.5E-03** | **5.1E-04** | | **3.0E-03** |
| Surface Water | As | 3.0E-04 | 1.2E-04 | | 1.5E-03 | 1.4E-08 | 1.8E-08 | | 4.6E-05 | 1.5E-04 | | 1.9E-04 | 1.5E-03 | 2.7E-08 | 3.6E-08 | | 9.1E-05 | 2.9E-04 | | 3.9E-04 |
| | | | | | | | **Surface Water CTE Subtotal =** | | **4.6E-05** | **1.5E-04** | | **1.9E-04** | | | **Surface Water RME Subtotal =** | | **9.1E-05** | **2.9E-04** | | **3.9E-04** |
| | | | | | | | **Total CTE Non-carcinogenic Hazard =** | | **5.2E-03** | **5.0E-03** | | **1.0E-02** | | | **Total RME Non-carcinogenic Hazard =** | | **5.7E-02** | **5.0E-02** | | **1.1E-01** |

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

RME = Reasonable maximum exposure

Shaded cells are non-detects; value = 1/2 reporting limit.

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

**TABLE 8a**
**Summary of Carcinogenic Risks**
**Adult Recreationalist**

| Media | COPC | Cancer Slope Factor (mg/kg-day) | | | CENTRAL TENDENCY EXPOSURE SCENARIO | | | | | | | | REASONABLE MAXIMUM EXPOSURE SCENARIO | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CTE EPC (mg/kg); (mg/L) | Intake (mg/kg-day) | | | Carcinogenic Risk by Exposure Route | | | CTE Total Risk | RME EPC (mg/kg); (mg/L) | Intake (mg/kg-day) | | | Carcinogenic Risk by Exposure Route | | | RME Total Risk |
| | | Oral | Dermal | Inhalation | | Ingestion | Dermal | Inhalation | Ingestion | Dermal | Inhalation | | | Ingestion | Dermal | Inhalation | Ingestion | Dermal | Inhalation | |
| Mine Waste | As | 1.5E+00 | 3.7E+00 | 1.5E+01 | 1.6E+01 | 2.0E-08 | 5.1E-09 | 4.7E-12 | 3.0E-08 | 1.8E-08 | 7.1E-11 | 4.9E-08 | 2.2E+01 | 3.7E-07 | 6.2E-08 | 4.3E-11 | 5.6E-07 | 2.3E-07 | 6.5E-10 | 7.9E-07 |
| | | | | | | | | **Mine Waste CTE Subtotal =** | **3.0E-08** | **1.8E-08** | **7.1E-11** | **4.9E-08** | | | | **Mine Waste RME Subtotal =** | **5.6E-07** | **2.3E-07** | **6.5E-10** | **7.9E-07** |
| Sediment | As | 1.5E+00 | 3.7E+00 | 1.5E+01 | 1.6E+00 | 9.9E-10 | 6.8E-11 | | 1.5E-09 | 2.5E-10 | | 1.7E-09 | 2.1E+00 | 1.7E-08 | 4.1E-09 | | 2.6E-08 | 1.5E-08 | | 4.1E-08 |
| | | | | | | | | **Sediment CTE Subtotal =** | **1.5E-09** | **2.5E-10** | | **1.7E-09** | | | | **Sediment RME Subtotal =** | **2.6E-08** | **1.5E-08** | | **4.1E-08** |
| Surface Water | As | 1.5E+00 | 3.7E+00 | 1.5E+01 | 1.5E-03 | 3.8E-10 | 1.4E-09 | | 5.7E-10 | 5.0E-09 | | 5.5E-09 | 1.5E-03 | 2.5E-09 | 9.1E-09 | | 3.8E-09 | 3.3E-08 | | 3.7E-08 |
| | | | | | | | | **Surface Water CTE Subtotal =** | **5.7E-10** | **5.0E-09** | | **5.5E-09** | | | | **Surface Water RME Subtotal =** | **3.8E-09** | **3.3E-08** | | **3.7E-08** |
| | | | | | | | | **Total CTE Carcinogenic Risk =** | **3.2E-08** | **2.4E-08** | **7.1E-11** | **5.6E-08** | | | | **Total RME Carcinogenic Risk =** | **5.9E-07** | **2.7E-07** | **6.5E-10** | **8.6E-07** |

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

RME = Reasonable maximum exposure

Shaded cells are non-detects; value = 1/2 reporting limit.

mg/kg-day = Milligram per kilogram per day

mg/kg = Milligram per kilogram

mg/L = Milligram per liter

**TABLE 8b**
**Summary of Carcinogenic Risks**
**Child Recreationalist**

| Media | COPC | Cancer Slope Factor (mg/kg-day) Oral | Cancer Slope Factor (mg/kg-day) Dermal | Cancer Slope Factor (mg/kg-day) Inhalation | CENTRAL TENDENCY EXPOSURE SCENARIO: CTE EPC (mg/kg); (mg/L) | CTE Intake (mg/kg-day) Ingestion | CTE Intake (mg/kg-day) Dermal | CTE Intake (mg/kg-day) Inhalation | CTE Carcinogenic Risk by Exposure Route Ingestion | CTE Carcinogenic Risk by Exposure Route Dermal | CTE Carcinogenic Risk by Exposure Route Inhalation | CTE Total Risk | REASONABLE MAXIMUM EXPOSURE SCENARIO: RME EPC (mg/kg); (mg/L) | RME Intake (mg/kg-day) Ingestion | RME Intake (mg/kg-day) Dermal | RME Intake (mg/kg-day) Inhalation | RME Carcinogenic Risk by Exposure Route Ingestion | RME Carcinogenic Risk by Exposure Route Dermal | RME Carcinogenic Risk by Exposure Route Inhalation | RME Total Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mine Waste | As | 1.5E+00 | 3.7E+00 | 1.5E+01 | 1.6E+01 | 1.3E-07 | 5.1E-08 | 8.0E-12 | 1.9E-07 | 1.9E-07 | 1.2E-10 | 3.8E-07 | 2.2E+01 | 1.4E-06 | 5.2E-07 | 2.2E-11 | 2.1E-06 | 1.9E-06 | 3.3E-10 | 4.0E-06 |
| | | | | | | | | **Mine Waste CTE Subtotal =** | **1.9E-07** | **1.9E-07** | **1.2E-10** | **3.8E-07** | | | | **Mine Waste RME Subtotal =** | **2.1E-06** | **1.9E-06** | **3.3E-10** | **4.0E-06** |
| Sediment | As | 1.5E+00 | 3.7E+00 | 1.5E+01 | 1.6E+00 | 6.2E-09 | 4.1E-10 | | 9.3E-09 | 1.5E-09 | | 1.1E-08 | 2.1E+00 | 6.4E-08 | 5.4E-09 | | 9.6E-08 | 2.0E-08 | | 1.2E-07 |
| | | | | | | | | **Sediment CTE Subtotal =** | **9.3E-09** | **1.5E-09** | | **1.1E-08** | | | | **Sediment RME Subtotal =** | **9.6E-08** | **2.0E-08** | | **1.2E-07** |
| Surface Water | As | 1.5E+00 | 3.7E+00 | 1.5E+01 | 1.5E-03 | 1.2E-09 | 1.5E-09 | | 1.8E-09 | 5.7E-09 | | 7.4E-09 | 1.5E-03 | 2.3E-09 | 3.1E-09 | | 3.5E-09 | 1.1E-08 | | 1.5E-08 |
| | | | | | | | | **Surface Water CTE Subtotal =** | **1.8E-09** | **5.7E-09** | | **7.4E-09** | | | | **Surface Water RME Subtotal =** | **3.5E-09** | **1.1E-08** | | **1.5E-08** |
| | | | | | | | | **Total CTE Carcinogenic Risk =** | **2.0E-07** | **1.9E-07** | **1.2E-10** | **3.9E-07** | | | | **Total RME Carcinogenic Risk =** | **2.2E-06** | **1.9E-06** | **3.3E-10** | **4.1E-06** |

Notes:

COPC = Contaminant of potential concern

CTE = Central tendency exposure

EPC = Exposure point concentration

RME = Reasonable maximum exposure

Shaded cells are non-detects; value = 1/2 reporting limit.

mg/kg-day = Milligram per kilogram per day

mg/L = Milligram per liter

**TABLE 9**
**Summary of Receptors Risks and Hazards**

| | CENTRAL TENDENCY EXPOSURE | | | | REASONABLE MAXIMUM EXPOSURE | | | |
|---|---|---|---|---|---|---|---|---|
| | NON-CARCINOGENIC HAZARD | | CARCINOGENIC RISK | | NON-CARCINOGENIC HAZARD | | CARCINOGENIC RISK | |
| | Receptor | | Receptor | | Receptor | | Receptor | |
| Media and Exposure Pathway | Recreationalist Adult | Recreationalist Child | Recreationalist Adult | Recreationalist Child | Recreationalist Adult | Recreationalist Child | Recreationalist Adult | Recreationalist Child |
| **Mine Waste:** | | | | | | | | |
| Ingestion | 5.E-04 | 5.E-03 | 3.E-08 | 2.E-07 | 3.E-03 | 5.E-02 | 6.E-07 | **2.E-06** |
| Dermal | 3.E-04 | 5.E-03 | 2.E-08 | 2.E-07 | 1.E-03 | 5.E-02 | 2.E-07 | **2.E-06** |
| Inhalation | | | 7.E-11 | 1.E-10 | | | 7.E-10 | 3.E-10 |
| Subtotal = | 8.E-04 | 1.E-02 | 5.E-08 | 4.E-07 | 4.E-03 | 1.E-01 | 8.E-07 | **4.E-06** |
| **Sediment:** | | | | | | | | |
| Ingestion | 3.E-05 | 2.E-04 | 1.E-09 | 9.E-09 | 1.E-04 | 3.E-03 | 3.E-08 | 1.E-07 |
| Dermal | 4.E-06 | 4.E-05 | 2.E-10 | 2.E-09 | 8.E-05 | 5.E-04 | 2.E-08 | 2.E-08 |
| Subtotal = | 3.E-05 | 3.E-04 | 2.E-09 | 1.E-08 | 2.E-04 | 3.E-03 | 4.E-08 | 1.E-07 |
| **Surface Water** | | | | | | | | |
| Ingestion | 1.E-05 | 5.E-05 | 6.E-10 | 2.E-09 | 2.E-05 | 9.E-05 | 4.E-09 | 4.E-09 |
| Dermal | 9.E-05 | 1.E-04 | 5.E-09 | 6.E-09 | 2.E-04 | 3.E-04 | 3.E-08 | 1.E-08 |
| Subtotal = | 1.E-04 | 2.E-04 | 6.E-09 | 7.E-09 | 2.E-04 | 4.E-04 | 4.E-08 | 1.E-08 |
| **TOTAL =** | 1.E-03 | 1.E-02 | 6.E-08 | 4.E-07 | 4.E-03 | 1.E-01 | 9.E-07 | **4.E-06** |

**Pathway Totals:**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ingestion | 6.E-04 | 5.E-03 | 3.E-03 | 2.E-07 | 3.E-03 | 6.E-02 | 6.E-07 | **2.E-06** |
| Dermal | 4.E-04 | 5.E-03 | 1.E-03 | 2.E-07 | 1.E-03 | 5.E-02 | 3.E-07 | **2.E-06** |
| Inhalation | | | 7.E-11 | 1.E-10 | | | 7.E-10 | 3.E-10 |

Notes:

Bold values exceed acceptable levels

**LONGSHOT MINE SITE INSPECTION**

**APPENDIX B**

**STREAMLINED ECOLOGICAL RISK ASSESSMENT**

## 1.0 INTRODUCTION

This report presents a streamlined screening level ecological risk assessment (ERA) prepared as part of the Site Inspection (SI) for the Longshot Mine ("the Site") in Stevens County, Washington. This ERA was completed in substantial conformance with the U.S. Environmental Protection Agency (EPA) "*Guidelines for Ecological Risk Assessment"* (1998).

The objective of this ERA is to evaluate the potential for ecological risks from exposure to mine-related contamination. A detailed description of the site location, background, field investigation, and physiography is presented in the main body of the SI report and will not be reiterated here.

This report is organized as follows:

- **Section 2** – Level 1 Scoping ERA
- **Section 3 –** Level 2 Screening ERA
- **Section 4** – Conclusions
- **Section 5** – References

Summary tables are provided throughout the text and risk screening and calculation tables are provided in Attachment A. An ecological scoping checklist completed during the field investigation is provided in Attachment B, and a list of sensitive plant and animal species is provided in Attachment C.

## 2.0 LEVEL 1 SCOPING ECOLOGICAL RISK ASSESSMENT

The objective of the Level 1 Scoping ERA is to qualitatively determine whether there are any potential ecological receptors or exposure pathways at the site. It requires an examination of the ecological setting of the site, presence of sensitive environments, presence of threatened or endangered (T&E) species, ecological stressors (contaminants of interest [COI]), and development of a conceptual site exposure model (CSEM). Each of these components is discussed in the following sections.

### 2.1 Ecological Setting

The site is located in the Colville National Forest and within the Okanogan Highlands Ecoregion. Terrestrial habitats in vicinity of the site include steep woodland hillsides, meadows, riparian zones, and wetland areas. The dominant vegetation types on the hillsides are *Thuja plicata* (interior western hemlock) and *Tsuga heterophylla* (interior red cedar). *Abies lasiocarpa* (subalpine fir) occurs in higher elevations, and *Pinus ponderosa* (Ponderosa pine) and *Arceuthobium douglasii* (Douglas fir) at lower elevations. The hillsides are characterized by a fairly dense overstory and understory. Dominant understory vegetation consists of *carex* spp., forbs, *salix* spp, *Equisetum* spp. and fern species.

A detailed description of the hydrologic setting of the site is presented in the SI report. In summary, the site is adjacent to an ephemeral tributary to South Fork Mill Creek, which is located about 1.5 miles downstream from the site. South Fork Mill Creek is a third order stream that drains into Mill Creek and then the Colville River.

An ecological scoping checklist was completed by Millennium Science and Engineering, Inc. (MSE) during the field investigation conducted in June 2005, and is provided as Attachment B.

### 2.2 Sensitive Environments

According to Washington Administrative Code (WAC) 173-340-200, a sensitive environment means "an area of particular environmental value, where a release could pose a greater threat than in other areas including: wetlands; critical habitat for endangered or threatened species; national or state wildlife refuge; critical habitat, breeding or feeding area for fish or shellfish; wild or scenic river; rookery; riparian area; big game winter range."

Based on this definition, sensitive environments within 2 miles of the Site include:

- Jurisdictional wetlands on South Fork Mill Creek, as summarized in the SI report; and
- Threatened species listed in Attachment C that occur within the Colville National Forest.

### 2.3 Threatened and Endangered Species

"T&E species" are species listed as threatened or endangered under the federal Endangered Species Act 16 U.S.C. Section 1533, or classified as threatened or endangered by the State Fish and Wildlife Commission under WAC 232-12-011(1) and 232-12-014.

A list of T&E wildlife and plant species and species of concern (SOC) occurring in the Colville National Forest and Eastern Washington was compiled from information obtained from the U.S. Fish and Wildlife Service (FWS) Upper Columbia River Field Office (2005), and U.S. Forest Service (USFS) Colville National Forest Office (2005). The list of animal and plant T&E species and SOC in the Colville National Forest is provided in Attachment C.

Spatial data for animal and plant habitats within the Colville National Forest was obtained from a USFS website at http://www.fs.fed.us/r6/data-library/gis/colville/index.html and incorporated into a geographic information system (GIS) to help in identifying critical habitat locations. The available and functional shapefiles for listed species were input into ArcMap and overlain with the site location. Based on the available data, grizzly bear and Woodland caribou habitat are not present at the site. The boundary of Canada lynx habitat is adjacent to the site and may or may not include the site. Habitat data for the bald eagle and gray wolf were not available.

During the field investigation conducted by MSE in June 2005, no terrestrial or aquatic T&E or rare species were observed.

### 2.4 Contaminants of Interest

The following COIs were identified based on analytical results of samples collected during the field investigation at the site: aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver, vanadium, and zinc. All of these COIs are present in the waste rock and tailings at the site. However, the surface water, pore water, and sediment samples contained only a few of the COIs. During the Level 2 Screening discussed in Section 3.0 of this report, COIs are examined further to identify contaminants of potential ecological concern (CPECs) and the potential risk to ecological receptors.

## 2.5 Conceptual Site Exposure Model

A CSEM illustrates the general understanding of the sources of contamination, release and transport mechanisms, impacted exposure media, potential exposure routes, and ecological receptors at the site. At this site, the primary sources of CPECs include the waste rock piles and tailings impoundments. Precipitation could result in the following release/transport mechanisms from the waste rock piles and tailings impoundments: runoff, leaching, percolation, or infiltration into surface or subsurface soils, groundwater, or surface water. CPECs in the adit discharge and ponds can follow a similar pathway. Once in the groundwater, CPECs can be transported to surface water, where they can be deposited to sediment or transported downstream as a dissolved constituent, or attached to suspended sediment.

Based on current knowledge of the site, potential exposure media at the site includes waste rock, tailings, soil, and surface water and sediment in the adit discharge, ponds, and ephemeral tributary seeps.

Potential ecological receptors at the site include terrestrial wildlife (plants, birds, invertebrates, reptiles and amphibians, and mammals) and aquatic biota (invertebrates). No T&E species were observed during the field investigation and based on the available data, only the Canada lynx (*Lynx canadenis*) has potential habitat near the site. No habitat data were available for the Gray wolf (*Canis lupus*), bald eagle (*Haliaeetus leucocephalus*), and Ute Ladies' –tresses (*Spiranthes diluvialis*); and, according to the USFS Colville National Forest hydrologist, bull trout (*Salvelinus confluentus*) do not occur in the South Fork of Mill Creek (Personal Communication, B. Wasson 2005).

Figure B.1 illustrates the CSEM and includes complete as well as incomplete or insignificant exposure routes.

# 3.0 LEVEL 2 SCREENING ECOLOGICAL RISK ASSESSMENT

A Level 2 Screening ERA was conducted to evaluate data collected during the field investigation and identify those contaminants and media that pose potential risks to ecological receptors at the Site. The Level 2 Screening consists of:

- Reviewing the exposure pathways and receptors present on the site;
- Identifying assessment and measurement endpoints;
- Identifying exposure point concentrations (EPCs) for use in the ecological risk screening; and
- Identifying CPECs.

## 3.1 Exposure Pathway and Receptor Summary

The exposure pathways to be qualitatively and quantitatively addressed are illustrated in the CSEM (Figure B.1) and discussed in this risk assessment. In summary, the exposure pathways addressed in this ERA include:

- Incidental ingestion of soil (mine waste) and sediment;
- Direct contact with soil (mine waste), sediment, surface water, and pore water; and
- Ingestion of surface water.

### 3.2 Ecological Endpoints

Identification of ecological endpoints guides the completion of the risk characterization portion of the ERA. Assessment and measurement endpoints for this ERA were developed based on the CSEM for the site and are discussed in the following sections.

#### *3.2.1 Assessment Endpoints*

According to the EPA, an assessment endpoint is a "formal expression of an actual environmental value to be protected… an environmental value which would indicate a need for remediation." The assessment endpoints for this ERA include:

- Survival and reproductive success of non-protected terrestrial receptors (invertebrates, birds, mammals, and vegetation) and;
- Survival and reproductive success of aquatic life (invertebrates).

#### *3.2.2 Measurement Endpoints*

According to the EPA, a measurement endpoint is a "quantitative expression of an observed or measured effects of a hazard; and, these measurable environmental characteristics are related to the valued characteristics chosen as assessment endpoints." Typically, measurement endpoints will dictate the type of samples and/or data to be collected and assessed to address the impact of stressors on the ecological receptors. The measurement endpoint for this ERA includes:

- Comparison of the measured concentrations of the COIs in soil, waste rock, tailings, surface water, and sediment to their respective ecological risk-based screening level values (SLVs).

### 3.3 Exposure Point Concentrations

Ecological receptors do not experience their environment on a "point" basis; therefore, it is necessary to convert measured data from single sample points into an estimate of concentration over their habitat to conduct an appropriate risk screening. For this assessment, EPCs were based on either the maximum detected concentration (MDC) or 95 percent upper confidence limit ($UCL_{95}$) of the mean from the analytical results, depending on the ecological receptor as outlined below:

- For invertebrates (such as worms) and plants, the MDC was used as the EPC, and
- For birds and mammals, the $UCL_{95}$ was used as the EPC.

The $UCL_{95s}$ were calculated using EPA's PROUCL statistical program. The program computes UCLs for each data set using several methods and recommends one based on the data distribution. However, data sets with fewer than 10 data samples can provide statistically unreliable estimates of the true average and may occasionally exceed the MDC. In those instances, the MDC was used in place of the $UCL_{95}$.

### 3.4 Preliminary Screening of Contaminants of Interest

Prior to conducting an ecological risk-based screening, COIs were first subjected to preliminary screening. The preliminary screening consists of removing COIs from further analysis if they exhibit the following characteristics:

- Qualify as an essential nutrient;
- Were detected in fewer than 5 percent of the samples by media type; or
- Are present in concentrations below background concentrations.

The preliminary screening tables (Tables 1 through 4) are provided in Attachment A. Compounds with MDCs below background levels were eliminated from further screening. Compounds in mine waste were compared to $UCL_{95}$ concentrations in the background soil samples. For surface water and sediment, only a single background sample was collected and represented the background concentrations. For pore water, only two samples were collected; the upstream sample was considered background and the downstream sample concentrations were simply compared to the upstream concentrations. In all screening, if the $UCL_{95}$ concentrations exceeded the MDC, the MDC was used in place of the $UCL_{95}$.

Four of the COIs were determined to be essential nutrients: calcium, magnesium, potassium, and sodium. These COIs were removed from further analysis. Iron is also an essential nutrient. The frequency of detection screening and background concentrations screening were both performed for each media and the results are summarized in Tables B.1 and B.2, respectively.

**Table B.1. Frequency of Detection Screening Results**

| Media | Frequency of Detection |
|---|---|
| Mine Waste | All COIs except beryllium, selenium, and thallium were detected in more than 5% of the samples; therefore, they were retained for additional analysis. |
| Surface Water | Besides essential nutrients, only barium, manganese, and zinc were detected in more than 5% of the samples and therefore, were retained for additional analysis. |
| Sediment | Antimony, mercury, and cyanide were not detected in any of the sediment samples and therefore, were removed from further analysis. All other COIs were detected in more than 5% of the samples and therefore, were retained for additional analysis. |
| Pore Water | Besides essential nutrients, only barium and manganese were detected in more than 5% of the samples and therefore, were retained for additional analysis. |

**Table B.2. Background Screening Results**

| Media | Frequency of Detection |
|---|---|
| Mine Waste | All COIs, except for barium, were detected at maximum concentrations above background concentrations and therefore, were retained for additional analysis. |
| Surface Water | All COIs with detectable concentrations (barium, manganese, and zinc) except for essential nutrients, exceeded background concentrations and therefore, were retained for additional analysis. |
| Sediment | All COIs, except for the essential nutrient sodium, exceeded background concentrations and therefore, were retained for additional analysis. |
| Pore Water | All COIs with detectable concentrations, except for the essential nutrient calcium, were less than background concentrations and therefore, were removed from further analysis. |

## 3.5 Chemistry-toxicity Screening

This task of the ERA requires comparing the EPCs to ecological risk-based SLVs. Typically, SLVs are obtained from WDOE MTCA (2001); however, there were some instances where SLVs were not available in these documents. In such instances, SLVs were obtained from other sources (EPA and ORNL) or substituted from a surrogate contaminant when appropriate. SLVs for the exposure media are presented in Tables 5 though 7 in Attachment A.

A chemistry-toxicity screen was performed based on the following conditions:

- Exposure to a single COI in an exposure medium;
- Exposure to multiple COIs in an exposure medium; and
- Exposure to individual COIs in multiple exposure media.

Potential ecological risk from exposure to a single COI in an exposure medium was assessed by calculating contaminant-specific risk ratios ($T_{ij}$). Risk ratios for each COI are calculated by dividing the EPC by the SLV. The risk ratios are then compared to receptor-specific risk ratios (Q-factors) to evaluate potential ecological risk. In general, higher risk ratios present a greater likelihood that a CPEC concentration will adversely affect ecological receptors. Risk ratios greater than 1 (Q=1) indicate potential risk for protected (i.e., federally listed T&E species) while risk ratios greater than 5 (Q=5) indicate potential risk to non-protected receptors. A Q-factor of 5 was used in this streamlined ERA because, although T&E species have been identified in the Colville National Forest (Attachment C), there appears to have been no documented occurrences at the site and none were observed during the field investigation. Therefore, COIs with risk ratios greater than 5 were retained as CPECs.

Potential ecological risk from exposure to multiple COIs in a single exposure medium was assessed by calculating the ratio of a contaminant-specific risk ratio to the overall risk (sum of all contaminant-specific risk ratios) presented in a medium. Again, if the ratio for a particular COI contributed an inordinate amount (> 5) to the overall risk, it was retained as a CPEC.

Potential ecological risk from exposure to a single COI in multiple exposure media was assessed by comparing the total risk posed by a COI in multiple media to a Q-factor of 5. If the total risk was greater than 5, then the COI was retained as a CPEC.

The results of the chemistry-toxicity screen are presented in Tables 5 through 8 in Attachment A, and summarized in the following sections according to exposure media. The screening results are summarized in Tables B.3 through B.8, and the identified CPECs in each media for the separate ecological receptors are summarized in Table B.9.

### *3.5.1 Mine Waste Chemistry-Toxicity Screening Results*

Table 5 in Attachment A presents the chemistry-toxicity screen calculations and results for the mine waste samples. The CPECs identified based on the single COI and multiple COI chemistry-toxicity screens are summarized in Tables B.3 and B.4. Chromium, mercury, and cyanide were also retained as CPECs in the mine waste because of the lack of SLVs.

**Table B.3. Identified Mine Waste CPECs by Single COI Contaminant-Toxicity Screening**

| CPEC | Plant | Invertebrate | Bird | Mammal |
|---|---|---|---|---|
| Aluminum | X | X | X | X |
| Antimony | X | | | |
| Cadmium | X | X | X | |
| Cobalt | | X | | |
| Copper | | X | | |
| Iron | | X | | |
| Lead | X | X | X | X |
| Manganese | | X | | |
| Silver | X | X | | |
| Vanadium | X | X | | |
| Zinc | X | X | X | X |

Notes:
COI = Contaminant of interest
CPEC = contaminant of potential ecological concern
CPECs identified by the lack of SLVs are not included.

**Table B.4. Identified Mine Waste CPECs by Multiple COI Contaminant-Toxicity Screening**

| CPEC | Plant | Invertebrate | Bird | Mammal |
|---|---|---|---|---|
| Aluminum | | | X | |
| Cadmium | | | X | |
| Lead | | X | X | X |
| Zinc | | X | X | |

Notes:
COI = Contaminant of interest
CPEC = contaminant of potential ecological concern
CPECs identified by the lack of SLVs are not included.

### *3.5.2 Surface Water Chemistry-Toxicity Screening Results*

Table 6 in Attachment A presents the chemistry-toxicity screen calculations and results for the surface water samples. No CPECs were identified. Zinc and barium were the only COIs that continued onto Level 2 Screening, resulting in risk ratios less than 0.01 for all receptors. Calcium, potassium, and magnesium exceeded background concentrations, but are considered essential nutrients and were excluded from Level 2 Screening.

### *3.5.3 Sediment Ecological Chemistry-Toxicity Screening Results*

Table 7 in Attachment A presents the chemistry-toxicity screen calculations and results for the sediment samples and Table B.7 summarizes the identified sediment CPECs. Cadmium and zinc were identified as CPECs because of their high-risk ratios. Aluminum, barium, cobalt, iron, manganese, silver, and vanadium were also retained as CPECs because the lack of SLVs.

### *3.5.4 Pore Water Ecological Chemistry-Toxicity Screening Results*

No COIs were identified through the preliminary COI screening process, thus Level 2 Screening was not necessary. The only potential COIs identified in the pore water samples were essential nutrients that exceeded background concentrations, such as calcium, magnesium, and sodium.

**Table B.7. Identified Sediment CPECs by Contaminant-Toxicity Screen**

| CPEC | Freshwater Sediment Risk | Bioaccumulation Risk |
|---|---|---|
| Cadmium | | X |
| Zinc | | X |

Notes:
CPEC = contaminant of potential ecological concern
CPECs identified by the lack of SLVs are not included.

### 3.6 Bioaccumulation Screen

Special attention must be given to COIs that are, or are suspected of being, persistent bioaccumulative toxins. In the suite of COIs identified for this ERA, metals with the most bioaccumulative potential include cadmium and zinc.

### 3.7 SLV Availability Screen

In some instances, SLVs were not available for a given COI-media-receptor combination. Although estimating the toxicity or bioaccumulative potential of the COI was not possible, the COI was retained as a potential CPEC and not removed from further consideration. Table B.8 provides a summary of the COI-media-receptor combinations that do not have available SLVs.

### 3.8 Risk Characterization

Risk characterization is comprised of describing the risks to ecological receptors and the uncertainties in the ERA. The objective of the risk description is to assess whether the predicted risks are likely to occur at the site. The objective of the uncertainties analysis is to examine the data gaps or sources of variability in the ERA process and whether these uncertainties under estimate or over estimate the ecological risks at the Site. The uncertainty evaluation is described in Section 3.9 of this report.

The following sections discuss the risk characterization for each media and CPECs identified in the process are summarized in Table B.9.

#### *3.8.1 Mine Waste*

Fourteen CPECs were identified for mine waste: aluminum, antimony, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, silver, vanadium, zinc, and cyanide. Of these, aluminum, lead, and zinc can be considered the most significant CPECs because they pose a potential threat to all ecologic receptors.

Invertebrates were the most susceptible receptor to risks from the following 10 CPECs: aluminum, cadmium, cobalt, copper, iron, lead, manganese, silver, vanadium, and zinc. All COIs had assigned SLVs for the invertebrate ecological receptor. Of these COIs, cadmium, lead, silver, and zinc exceeded single COI risk ratios of 100, in particular lead exceeded 800. Lead and zinc also were identified as CPECs because of multiple COI risks to the invertebrate receptor group.

**Table B.8. Availability of SLVs Screening Results**

| COI | Plants | Inverts | Birds | Mammals | Aquatic Life | Bioaccumulation |
|---|---|---|---|---|---|---|
| ***Mine Waste*** | | | | | | |
| Aluminum | | | | X | | |
| Antimony | | | X | | | |
| Chromium | | | X | | | |
| Cobalt | | | X | | | |
| Cyanide | X | | X | X | | |
| Iron | X | | X | X | | |
| Manganese | | | X | | | |
| Mercury | | | X | X | | |
| Silver | | | X | X | | |
| ***Sediment*** | | | | | | |
| Aluminum | | | | | X | X |
| Barium | | | | | X | X |
| Cobalt | | | | | X | X |
| Iron | | | | | X | X |
| Manganese | | | | | X | X |
| Silver | | | | | | X |
| Vanadium | | | | | X | X |

Notes:
A total of 28 COI-media-receptors were not assessed because of a lack of data.
X = SLV not available; COI = contaminant of interest; SLV = screening level value

The vegetation ecological group was susceptible to risk from seven CPECs: aluminum, antimony, cadmium, lead, silver, vanadium, and zinc. Multiple COI risk was not identified for any metals for the vegetation group. Three risk ratios are particularly elevated in comparison to other metals; aluminum (654), lead (600), and zinc (455).

Four CPECs were identified as posing risk to the bird ecological receptor group: aluminum, cadmium, lead, and zinc. Lead and zinc have high-risk ratios, and were also CPECs for multiple COI risk. Antimony, chromium, cobalt, copper, iron, manganese, silver, and cyanide were also retained as potential CPECs because of the lack of assigned SLVs for the bird receptor group.

Two CPECs were identified as posing risk to the mammals ecological receptor group: lead and zinc. Aluminum, iron, mercury, silver and cyanide were retained as potential CPECs because of the lack of assigned SLVs. Only lead poses multiple COI risk for the mammal group.

### *3.8.2 Surface Water*

The surface water screening indicated that no CPECs pose risk to aquatic life, bird, or mammal receptor groups. Barium and Zinc were the only COIs that continued onto the Level 2 Screening process. Risk ratios did not exceed 0.01 for any receptor group. Essential nutrients such as calcium, potassium, magnesium, and sodium exceeded background concentrations, but were not retained for Level 2 Screening.

**Table B.9. CPEC Summary**

| CPEC | Mine Waste | Surface Water | Sediment | Pore Water |
|---|---|---|---|---|
| Aluminum | P,I,B | | | |
| Antimony | P | | | |
| Cadmium | P,I,B | | AL | |
| Cobalt | I | | | |
| Copper | I | | | |
| Iron | I | | | |
| Lead | P,I,B,M | | | |
| Manganese | I | | | |
| Silver | P,I | | | |
| Vanadium | P,I | | | |
| Zinc | P,I,B,M | | AL | |

Notes:
AL = aquatic Life; B = birds; CPEC = contaminant of potential ecological concern; I = invertebrates; M = mammals; P = plants
CPECs identified based on lack of SLVs are not included in this summary.

### *3.8.3 Sediment*

Nine CPECs were identified in sediment based on:

- Exceeding the bioaccumulation SLV (cadmium and zinc);
- Lacking SLVs for freshwater sediment (aluminum, barium, cobalt, iron, silver, manganese, and vanadium);
- Lacking SLVs for bioaccumulation (aluminum, barium, cobalt, iron, manganese, silver, and vanadium); or
- Potential for bioaccumulation (cadmium and zinc).

This data suggests that sediment might be a potential risk to ecological receptors in the aquatic environment, in particular cadmium and zinc. The highest level of risk is posed by the bioaccumulation of cadmium in the sediment with a bioaccumulation risk ratio of 1,499. Zinc also had a high bioaccumulation risk ratio of 115. Both of these risk ratios are significantly above the acceptable risk ratio of 5. The lack of historical macroinvertebrate community data at the site does not allow for a pre- and post-mine evaluation. Furthermore, lack of macroinvertebrate or fish tissue analysis precludes assessing bioaccumulation of metals in the food chain. Overall, the primary CPECs in sediment at the site include: cadmium and zinc.

### *3.8.4 Pore Water*

No CPECs were identified for pore water. Only two pore water samples were taken and many of the COIs were not detectable. Essential nutrients (calcium, potassium, sodium, and magnesium) were identified in the samples, but were not carried through the Level 2 Screening.

## 3.9 Uncertainty Evaluation

There are several sources of uncertainty associated with this ERA. These sources and their potential impact on the prediction for potential risks to ecological receptors at the site are discussed in the following sections.

### *3.9.1 Sample Data*

The selection of sampling media, sample locations, quantity of samples, sampling procedures, and sample analysis introduce some uncertainties into this ERA. For example, time and monetary restraints limit the number of samples that can be collected; therefore, sample locations are selected based on knowledge of anticipated presence of particular contaminants. Overall, the data used in this risk assessment were generally collected from areas with expected elevated metals concentrations. As a result, this assessment likely over estimates the risk posed to ecologic receptors at the site.

The lack of established SLVs for several COIs were another source of uncertainty in the ERA. A total of 28 receptor-media-COI combinations were retained as CPECs because of the lack of SLVs rather than because of high risk ratios. This may result in an over estimation of the overall potential for ecological risk at the site.

### *3.9.2 Screening Level Values*

"NOAEL" is the acronym used for "No Observed Adverse Effect Level." It means the highest exposure level at which there are no statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered to be adverse, nor precursors to specific adverse effects (WAC 173-340-200).

"LOAEL" is the acronym used for "Lowest Observed Adverse Effect Level" which means the lowest concentration of a hazardous substance at which there is a statistically or biologically significant increase in the frequency or severity of an adverse effect between an exposed population and a control group (WAC 173-340-200).

The ecological risk-based SLVs used in this ERA are intended to be NOAELs, with the exception of sediment SLVs. Ecological effects occur at some concentration between the NOAELs and the LOAELs; therefore, concentrations exceeding the SLV do not necessarily constitute a "real" risk for ecological receptors. Thus, use of NOAEL-based SLVs results in an over estimation of actual ecological risks at the site.

### *3.9.3 CPEC Selection*

The CPEC background concentration screening for surface water and sediment was based on only one background sample. Concentrations of contaminants, particularly metals, are naturally variable; therefore, a single sample does not accurately reflect "natural" conditions. As a result, improper inclusion of contaminants during the background screening may result in over estimating actual risks, and improper exclusion of contaminants may result in under estimating actual risks. In addition, the use of MDCs and the $UCL_{95s}$ as EPCs may inherently introduce conservatism and contribute to over estimation of risk at the site.

## 4.0 CONCLUSIONS

Results of the streamlined ERA indicate some potential risk to ecological receptors at the Longshot Mine site. However, these risks appear to be limited to individual receptors and there does not appear to be any population-level risks. While individual receptors may be at risk from exposure to CPECs at the site, their populations are unlikely to be significantly impacted in the vicinity of the mine because it is unlikely that entire populations would reside entirely within the contaminated areas of the site. These areas typically offer lower habitat quality compared to adjoining habitat; therefore, it is unlikely that a receptor would limit its habitat strictly to these areas. Although there is no evidence of T&E species inhabiting the site and none were observed during the field investigation, available data from the USFS and FWS identify known and potential T&E habitats within the Colville National Forest. Therefore, these species may occasionally traverse the site.

The calculated ecological risk ratios are summarized in Table B.10. Lead and zinc appear to be the primary CPECs posing the most significant site-wide risk to plants, invertebrates, birds, and mammals. Lead and zinc in the mine waste pose the most risk with risk ratios ranging from 112 to 888, and from 30 to 601, respectively. Silver and aluminum also pose significant risk to plants and invertebrates with risk ratios ranging from 88 to 143, and from 44 to 654, respectively.

**Table B.10. Summary of Calculated Ecological Risk Ratios**

| CPEC | Mine Waste | | | | Sediment |
|---|---|---|---|---|---|
| | Plant | Invertebrate | Bird | Mammal | Aquatic Receptors |
| Aluminum | 654 | 44 | 46 | | |
| Antimony | 18 | | | | |
| Cadmium | 48 | 107 | 26 | | 1,499 |
| Cobalt | | 10 | | | |
| Copper | | 17 | | | |
| Iron | | 68 | | | |
| Lead | 600 | 888 | 825 | 112 | |
| Manganese | | 27 | | | |
| Silver | 88 | 143 | | | |
| Vanadium | 68 | 7 | | | |
| Zinc | 455 | 601 | 181 | 30 | 115 |

Notes:
Summary of risk ratios above the acceptable level of 5 for non-sensitive species.
CPEC = Contaminant of potential ecological concern

Invertebrates appear to be the most susceptible group to metal concentrations, particularly lead and zinc, in the mine waste (10 CPECs identified). The primary CPECs for the soil-plant combination exhibit elevated concentrations across the entire site or have the potential to bioaccumulate, and include: aluminum, lead and zinc. The primary CPECs posing a risk to birds and mammals from exposure to the mine waste include lead and zinc.

Surface water and pore water do not have any CPECs that were identified for COI risk. Risk posed to wildlife and avian receptors from exposure to contaminated surface water is not elevated (risk ratios less than the Q-factor). These results illustrate that the Site does not appear to be causing elevated risks to ecologic receptors exposed to surface water in the adit discharge, ponds, ephemeral tributary, or South Fork Mill Creek.

Two sediment CPECs (cadmium and zinc) were identified as posing a risk to aquatic receptors from direct exposure and/or bioaccumulation. Overall, the presence of elevated metal concentrations in the site sediment indicates there is some risk to aquatic macroinvertebrates, especially from the bioaccumulation of cadmium and zinc.

## 5.0 REFERENCES


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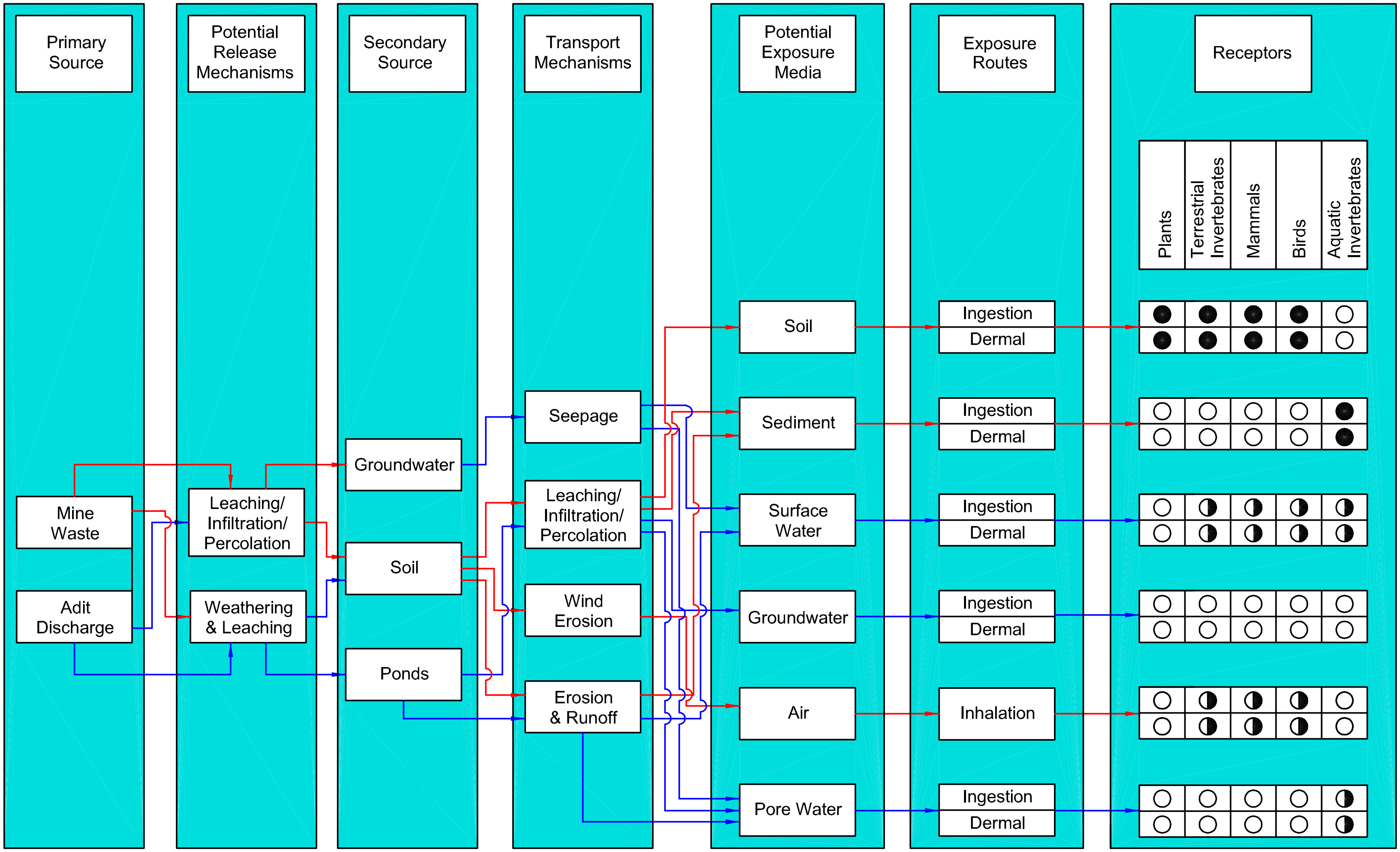


Legend

- ● Complete and potentially significant exposure pathway
- ◑ Potentially complete but insignificant exposure pathway
- ○ Incomplete exposure pathway

MSE Millenium Science and Engineering, Inc.
1605 North 13th Street
Boise, Idaho 83702
Phone: (208) 345-8292

**Ecological Conceptual Site Exposure Model**

| | | | |
|---|---|---|---|
| B2473B | 11-01-05 | ERA CSM.dwg | FIGURE B.1 |

# Attachment A

# Risk Calculation Tables

**TABLE 1**
**Ecological Risk Assessment: Preliminary Screening - Mine Waste**
**(results are reported in mg/kg)**

| Analyte | Minimum Detected Concentration | Maximum Detected Concentration | 95% UCL[1] | Essential Nutrient? | Retained For Screening? | Detection Frequency | Retained for Screening? | Background 95% UCL Concentration[1,2] | Include for Risk Based Screening? |
|---|---|---|---|---|---|---|---|---|---|
| Aluminum | 1330 | 32700 | 20607 | No | Yes | 100% | Yes | 27117 | **Yes** |
| Antimony | 1 U | 88.5 | 27.9 | No | Yes | 63% | Yes | | **Yes** |
| Arsenic | 3.5 | 41 | 22.2 | No | Yes | 100% | Yes | 5.9 | **Yes** |
| Barium | 4.92 | 83 | 35.2 | No | Yes | 100% | Yes | 203 | No |
| Beryllium | 0.5 U | 0.5 U | | No | Yes | 0% | No | | No |
| Cadmium | 1.96 | 191 | 157 | No | Yes | 100% | Yes | 3.74 | **Yes** |
| Calcium | 13200 | 342000 | 166069 | Yes | No | 100% | Yes | 29100 | No |
| Chromium | 6.64 | 49.1 | 29.4 | No | Yes | 100% | Yes | 37.30 | **Yes** |
| Cobalt | 1.5 U | 29.3 | 16.9 | No | Yes | 94% | Yes | 13.8 | **Yes** |
| Copper | 14.3 | 158 | 78.0 | No | Yes | 100% | Yes | 22.4 | **Yes** |
| Iron | 8040 | 68100 | 39780 | Yes | Yes | 100% | Yes | 27106 | **Yes** |
| Lead | 17 | 30000 | 13194 | No | Yes | 100% | Yes | 268 | **Yes** |
| Magnesium | 7550 | 99300 | 43925 | Yes | No | 100% | Yes | 12300 | No |
| Manganese | 442 | 2170 | 1476 | No | Yes | 100% | Yes | 1083 | **Yes** |
| Mercury | .01665 U | 0.994 | 0.994 | No | Yes | 38% | Yes | | **Yes** |
| Nickel | 5.1 | 44.7 | 32.2 | No | Yes | 100% | Yes | 37.0 | **Yes** |
| Potassium | 125 U | 4150 | 2125 | Yes | No | 100% | Yes | 3059 | No |
| Selenium | 1.5 U | 1.5 U | | No | Yes | 0% | No | | No |
| Silver | 0.25 U | 176 | 61.1 | No | Yes | 94% | Yes | | **Yes** |
| Sodium | 25 U | 582 | 264 | Yes | No | 75% | Yes | 365 | No |
| Thallium | 0.1 U | 1 U | | No | Yes | 0% | No | | No |
| Vanadium | 5.71 | 135 | 61.7 | No | Yes | 100% | Yes | 30.8 | **Yes** |
| Zinc | 136 | 39100 | 10860 | No | Yes | 100% | Yes | 651 | **Yes** |
| Cyanide | 0.025 U | 1.42 | | No | Yes | 6% | Yes | | **Yes** |

Notes:
1. Not computed for contaminants with less than 10% detected results.
2. If the 95% UCL exceeded the maximum detected concentration (MDC), used the MDC.
U = Analyzed for but not detected; value = 1/2 reporting limit.
mg/kg = Milligram per kilogram

**TABLE 2**
**Ecological Risk Assessment: Preliminary Screening - Surface Water**
**(results reported in mg/L)**

| Analyte[1] | Minimum Detected Concentration | Maximum Detected Concentration | 95% UCL[2] | Essential Nutrient? | Retained for Screening? | Detection Frequency | Retained for Screening? | Background Concentration[3] | Include for Risk-Based Screening? |
|---|---|---|---|---|---|---|---|---|---|
| Aluminum | 0.015 U | 0.015 U | - | No | Yes | 0% | No | 0.015 U | No |
| Antimony | 0.01 U | 0.01 U | - | No | Yes | 0% | No | 0.01 U | No |
| $Arsenic_{total}$ | 0.0015 U | 0.0015 U | - | No | Yes | 0% | No | 0.015 U | No |
| Barium | 0.003 | 0.015 | 0.015 | No | Yes | 100% | Yes | 0.012 | **Yes** |
| Beryllium | 0.001 U | 0.001 U | - | No | Yes | 0% | No | 0.001 U | No |
| Cadmium | 0.001 U | 0.001 U | - | No | Yes | 0% | No | 0.001 U | No |
| Calcium | 41.1 | 81.05 | 79.6 | Yes | No | 100% | Yes | 68.2 | No |
| Chromium | 0.003 U | 0.003 U | - | - | Yes | 0% | No | 0.003 U | No |
| $Chromium_6$ | 0.005 U | 0.005 U | - | - | Yes | 0% | No | 0.005 U | No |
| Cobalt | 0.003 U | 0.003 U | - | No | Yes | 0% | No | 0.003 U | No |
| Copper | 0.005 U | 0.005 U | - | No | Yes | 0% | No | 0.005 U | No |
| Cyanide | 0.005 U | 0.005 U | - | - | Yes | 0% | No | 0.005 U | No |
| Iron | 0.03 U | 0.03 U | - | No | Yes | 0% | No | 0.03 U | No |
| Lead | 0.0015 U | 0.0015 U | - | No | Yes | 0% | No | 0.0015 U | No |
| Magnesium | 3.34 | 8.28 | 6.05 | Yes | No | 100% | Yes | 3.65 | No |
| Manganese | 0.002 U | 0.016 | 0.014 | No | Yes | 40% | No | 0.002 U | No |
| $Mercury_{total}$ | 0.0001 U | 0.0001 U | - | No | Yes | 0% | No | 0.0001 U | No |
| Nickel | 0.005 U | 0.005 U | - | No | Yes | 0% | No | 0.005 U | No |
| Potassium | 1.5 | 1.94 | 1.73 | Yes | No | 100% | Yes | 1.63 | No |
| Selenium | 0.0015 U | 0.0015 U | - | - | Yes | 0% | No | 0.0015 U | No |
| Silver | 0.0025 U | 0.0025 U | - | - | Yes | 0% | No | 0.0025 U | No |
| Sodium | 3.34 | 4.46 | 3.77 | Yes | No | 100% | Yes | 4.89 | No |
| Thallium | 0.001 U | 0.001 U | - | No | Yes | 0% | No | 0.001 U | No |
| Vanadium | 0.0025 U | 0.0025 U | - | No | Yes | 0% | No | 0.0025 U | No |
| Zinc | 0.005 U | 0.066 | 0.066 | No | Yes | 20% | Yes | 0.005 U | **Yes** |

Notes:

1. Analyte is reported as the dissolved concentration in the water column, unless otherwise noted.
2. If the 95% UCL exceeded the maximum detected concentration (MDC), used the MDC.
3. Only one background surface water sample.

U = Analyzed for but not detected; value = 1/2 reporting limit.

mg/L = Milligram per liter

**TABLE 3**
**Ecological Risk Assessment: Preliminary Screening - Sediment**
**(results reported in mg/kg)**

| Analyte | Minimum Detected Concentration | Maximum Detected Concentration | 95% UCL[1] | Essential Nutrient? | Retained for Screening? | Detection Frequency | Retained for Screening? | Background Concentration[2] | Retained for Screening? |
|---|---|---|---|---|---|---|---|---|---|
| Aluminum | 6460 | 9290 | 8714 | No | Yes | 100% | Yes | 9010 | **Yes** |
| Antimony | 1 U | 1 U | - | No | No | 0% | No | 1 U | No |
| Arsenic | 0.61 | 2.71 | 2.05 | No | Yes | 100% | Yes | 0.84 | **Yes** |
| Barium | 22.9 | 58.1 | 44.23 | No | Yes | 100% | Yes | 30.2 | **Yes** |
| Cadmium | 0.29 | 7.41 | 4.50 | No | Yes | 100% | Yes | 0.34 | **Yes** |
| Calcium | 2870 | 34700 | 27296 | Yes | No | 100% | Yes | 5780 | No |
| Chromium | 7.94 | 16.0 | 13.54 | No | Yes | 100% | Yes | 13.6 | **Yes** |
| Cobalt | 2.85 | 5.22 | 4.56 | No | Yes | 100% | Yes | 3.47 | **Yes** |
| Copper | 5.6 | 26.2 | 19.56 | No | Yes | 100% | Yes | 10 | **Yes** |
| Iron | 7320 | 10900 | 9603 | Yes | Yes | 100% | Yes | 8950 | **Yes** |
| Lead | 3.32 | 90.4 | 48 | No | Yes | 100% | Yes | 5.01 | **Yes** |
| Magnesium | 1760 | 2850 | 2455 | Yes | No | 100% | Yes | 2810 | No |
| Manganese | 55 | 263 | 176 | No | Yes | 100% | Yes | 237 | **Yes** |
| Mercury | 0.0165 U | 0.0165 U | - | No | Yes | 0% | No | 0.0165 U | No |
| Nickel | 5.0 | 11.0 | 10.5 | No | Yes | 100% | Yes | 9.5 | **Yes** |
| Potassium | 851 | 1610 | 1363 | Yes | No | 100% | Yes | 1260 | No |
| Silver | 0.25 U | 0.95 | 0.95 | No | Yes | 13% | Yes | 0.25 U | **Yes** |
| Sodium | 126 | 207 | 175 | Yes | No | 100% | No | 395 | No |
| Vanadium | 11.8 | 20.8 | 16.7 | No | Yes | 100% | Yes | 12.9 | **Yes** |
| Zinc | 20.1 | 442 | 345 | No | Yes | 100% | Yes | 18.1 | **Yes** |
| Cyanide | 0.25 U | 0.25 U | - | No | Yes | 0% | No | 0.25 U | No |

Notes:
1. If the 95% UCL exceeded the maximum detected concentration (MDC), used the MDC.
2. Only one background sediment sample.
U = Analyzed for but not detected at reporting limit; value = 1/2 reporting limit.
mg/kg = Milligram per kilogram

**TABLE 4**
**Ecological Risk Assessment: Preliminary Screening - Pore Water**
**(results reported in mg/L)**

| Analyte[1] | Detected Concentration[2] | Essential Nutrient? | Retained for Screening? | Detection Frequency | Retained for Screening? | Background Concentration[3] | Retain for Screening? |
|---|---|---|---|---|---|---|---|
| Aluminum | 0.015 U | No | Yes | 0% | No | 0.015 U | No |
| Antimony | 0.01 U | No | Yes | 0% | No | 0.01 U | No |
| $Arsenic_{total}$ | 0.0015 U | No | Yes | 0% | No | 0.0015 U | No |
| Barium | 0.0134 | No | Yes | 100% | Yes | 0.0268 | No |
| Beryllium | 0.001 U | No | Yes | 0% | No | 0.001 U | No |
| Cadmium | 0.001 U | No | Yes | 0% | No | 0.001 U | No |
| Calcium | 42.1 | Yes | No | 100% | Yes | 37.2 | No |
| Chromium | 0.003 U | No | Yes | 0% | No | 0.003 U | No |
| Cobalt | 0.003 U | No | Yes | 0% | No | 0.003 U | No |
| Copper | 0.01 U | No | Yes | 0% | No | 0.01 U | No |
| Cyanide | 0.005 U | No | Yes | 0% | No | 0.005 U | No |
| Iron | 0.03 U | Yes | Yes | 50% | Yes | 0.075 | No |
| Lead | 0.002 U | No | Yes | 0% | No | 0.002 U | No |
| Magnesium | 3.51 | Yes | No | 100% | Yes | 3.61 | No |
| Manganese | 0.0072 | No | Yes | 100% | Yes | 0.123 | No |
| $Mercury_{total}$ | 0.00015 U | No | Yes | 0% | No | 0.00015 U | No |
| Nickel | 0.005 U | No | Yes | 0% | No | 0.005 U | No |
| Potassium | 1.67 | Yes | No | 100% | Yes | 2.23 | No |
| Selenium | 0.002 U | No | Yes | 0% | No | 0.002 U | No |
| Silver | 0.0025 U | No | Yes | 0% | No | 0.0025 U | No |
| Sodium | 3.33 | Yes | No | 100% | Yes | 3.54 | No |
| Thallium | 0.001 U | No | Yes | 0% | No | 0.001 U | No |
| Vanadium | 0.003 U | No | Yes | 0% | No | 0.003 U | No |
| Zinc | 0.005 U | No | Yes | 0% | No | 0.005 U | No |

Notes:
1. Analyte is reported as the dissolved concentration in the water column, unless otherwise noted.
2. Only two pore water samples were collected. Detected concentrations are for the downstream sample.
3. Only two pore water samples were collected. The upstream sample results were used for background concentrations.
U = Analyzed for but not detected; value = 1/2 reporting limit.
mg/L = Milligram per liter

**TABLE 5**
**Ecological Risk Assessment: Chemistry Toxicity Screening - Mine Waste**
**(results reported in mg/kg)**

| | | | **SCREENING LEVEL VALUES (WDOE 2005)** | | | | **RISK RATIOS ($T_{ij}$)** | | | | **RISK POSED TO NON-PROTECTED RECEPTORS? ($T_{ij} > 5$)** | | | | | **MULTIPLE COI RISK ($T_{ij}/T_j$)** | | | | **MULTIPLE COI RISK POSED TO NON-PROTECTED RECEPTORS? ($T_{ij}/T_j > 5/Nij$)** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analyte[1] | EPC (MDC)[2] | EPC (95% UCL)[3] | Plant | Invertebrate[4] | Bird[5] | Mammal | Plant | Invertebrate | Bird | Mammal | Plant | Invertebrate | Bird | Mammal | CPEC?[6] | Plant | Invertebrate | Bird | Mammal | Plant | Invertebrate | Bird | Mammal | CPEC? | **Bioaccumulator CPEC?** |
| Aluminum | 32700 | 20607 | 50 | 750 | 450 | NA | 654.00 | 43.60 | 45.79 | - | Yes | Yes | Yes | No | **Yes** | 0.3363 | 0.0233 | 5.7243 | - | No | No | Yes | No | **Yes** | No |
| Antimony | 88.5 | 27.9 | 5 | 1300 | NA | 15 | 17.70 | 0.07 | - | 1.86 | Yes | No | No | No | **Yes** | 0.0091 | 0.00004 | - | 0.0124 | No | No | No | No | No | No |
| Arsenic [6] | 41 | 22.2 | 10 | 360 | 10 | 29 | 4.10 | 0.11 | 2.22 | 0.77 | No | No | No | No | No | 0.0021 | 0.0001 | 0.2779 | 0.0051 | No | No | No | No | No | No |
| Cadmium | 191 | 157 | 4 | 1.79 | 6 | 125 | 47.75 | 106.70 | 26.18 | 1.26 | Yes | Yes | Yes | No | **Yes** | 0.0246 | 0.0570 | 3.2727 | 0.0084 | No | No | Yes | No | **Yes** | **Yes** |
| Chromium | 49.1 | 29.4 | 42 | 16 | NA | 410 | 1.17 | 3.07 | - | 0.07 | No | No | No | No | **Yes** | 0.0006 | 0.0016 | - | 0.0005 | No | No | No | No | No | No |
| Cobalt | 29.3 | 16.9 | 20 | 3 | NA | 150 | 1.47 | 9.77 | - | 0.11 | No | Yes | No | No | **Yes** | 0.0008 | 0.0052 | - | 0.0008 | No | No | No | No | No | No |
| Copper | 158 | 78.0 | 100 | 9.22 | 190 | 390 | 1.58 | 17.14 | 0.41 | 0.20 | No | Yes | No | No | **Yes** | 0.0008 | 0.0092 | 0.0513 | 0.0013 | No | No | No | No | No | No |
| Iron | 68100 | 39780 | NA | 1000 | NA | NA | - | 68.10 | - | - | No | Yes | No | No | **Yes** | - | 0.0364 | - | - | No | No | No | No | No | No |
| Lead | 30000 | 13194 | 50 | 33.78 | 16 | 118 | 600.00 | 888.10 | 824.63 | 111.81 | Yes | Yes | Yes | Yes | **Yes** | 0.3085 | 0.4744 | 103.0793 | 0.7468 | No | Yes | Yes | Yes | **Yes** | No |
| Manganese | 2170 | 1476 | 1100 | 80 | NA | 1500 | 1.97 | 27.13 | - | 0.98 | No | Yes | No | No | **Yes** | 0.0010 | 0.0145 | - | 0.0066 | No | No | No | No | No | No |
| Mercury | 0.994 | 0.994 | 0.3 | 2.4 | 1.5 | 5.5 | 3.31 | 0.41 | - | - | No | No | No | No | **Yes** | 0.0017 | 0.0002 | - | - | No | No | No | No | No | **Yes** |
| Nickel | 44.7 | 32.2 | 30 | 789 | 320 | 980 | 1.49 | 0.06 | 0.10 | 0.03 | No | No | No | No | No | 0.0008 | 0.0000 | 0.0126 | 0.0002 | No | No | No | No | No | No |
| Silver | 176 | 61.1 | 2 | 1.23 | NA | NA | 88.00 | 143.09 | - | - | Yes | Yes | No | No | **Yes** | 0.0453 | 0.0764 | - | - | No | No | No | No | No | **Yes** |
| Vanadium | 135 | 61.7 | 2 | 19 | 47 | 25 | 67.50 | 7.11 | 1.31 | 2.47 | Yes | Yes | No | No | **Yes** | 0.0347 | 0.0038 | 0.1641 | 0.0165 | No | No | No | No | No | No |
| Zinc | 39100 | 10860 | 86 | 65.04 | 60 | 360 | 454.65 | 601.17 | 181.01 | 30.17 | Yes | Yes | Yes | Yes | **Yes** | 0.2338 | 0.3211 | 22.6257 | 0.2015 | No | Yes | Yes | No | **Yes** | **Yes** |
| Cyanide | 1.42 | - | NA | 22 | NA | NA | - | 0.06 | - | - | No | No | No | No | **Yes** | - | 0.00003 | - | - | No | No | No | No | No | No |
| | | | | | Sum of $T_{ij}$ ($T_j$) = | | 1945 | 1872 | 1082 | 150 | | | | | | | | | | | | | | | |
| | | | | | # of COIs ($N_{ij}$) = | | 14 | 16 | 8 | 11 | | | | | | | | | | | | | | | |
| | | | | | $5/N_{ij}$ = | | 0.36 | 0.31 | 0.63 | 0.45 | | | | | | | | | | | | | | | |

Notes:
1. Contaminants retained after preliminary screening (essential nutrient, detection frequency, and background concentration comparison).
2. The EPC used for plant and invertebrate receptors is the maximum detected concentration.
3. The EPC used for bird and wildlife receptors is the 95% upper confidence limit.
4. Invertebrate screenling level values were obtained from Suter and Tsao, 1996.
5. NOAEL equivelant concentration in food for birds (represented by the American robin) from ORNL TM-86-R3 {1996}. Assumes diet is 20% soil- approximatly the 95th percentile of estimated percent soil in diet.
6. Some CPECs retained because of the lack of screening level values.

COI = Contaminant of interest
CPEC = Contaminant of potential ecological concern
EPC = Exposure point concentration
MDC = Maximum detected concentration
NA = Not available
NOAEL = No apparent effects level
WDOE = Washington Department of Ecology
mg/kg = Milligram per kilogram

**TABLE 6**
**Ecological Risk Assessment: Chemistry Toxicity Screening - Surface Water**
**(results reported in mg/L)**

| | | | SCREENING LEVEL VALUES[2] (WDOE 2005) | | | SINGLE COI RISK RATIO[3] | | | RISK TO RECEPTORS? | | | CPEC? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analyte[1] | EPC (MDC) | EPC (95% UCL) | Aquatic Life | Bird | Mammal | Aquatic Life | Bird | Mammal | Aquatic Life | Birds | Mammals | |
| Barium | 0.015 | 0.015 | 4 | 150000 | 39000 | 0.003825 | 0.0000001 | 3.92308E-07 | No | No | No | No |
| Zinc | 0.066 | 0.066 | 65.04 | 495 | 360 | 0.0010 | 0.0001 | 0.0002 | No | No | No | No |
| | | | | | Sum of $T_{ij}$ ($T_j$) = | 0.0048 | 0.0001 | 0.0002 | | | | |
| | | | | | # COIs ($N_{ij}$) = | 2 | 2 | 2 | | | | |
| | | | | | $1/N_{ij}$ = | 0.50 | 0.50 | 0.50 | | | | |
| | | | | | $5/N_{ij}$ = | 2.50 | 2.50 | 2.50 | | | | |

Notes:
1. Contaminants retained after preliminary screening (essential nutrient, detection frequency, and background concentration comparison).
2. The SLV is based on total concentrations; therefore, the EPC is expressed as the total concentration.
3. Single COI risk ratio (Tij) = EPC/SLV. All results were less than 1 so multiple COI risk ratios were not calculated.
COI = Contaminant of interest
CPEC = Contaminant of potential ecological concern
EPC = Exposure point concentration
MDC = Maximum detected concentration
NA = Not available
SLV = Screening level value
WDOE = Washington Department of Ecology
mg/L = Milligram per liter

**TABLE 7**
**Ecological Risk Assessment: Chemistry Toxicity Screening - Sediment**
**(results reported in mg/kg)**

| | | SLVs (WDOE 2001) | | RISK RATIOS ($T_{ij}$)[3] | | |
|---|---|---|---|---|---|---|
| Analyte[1] | EPC 95% UCL | Freshwater Sediment | Bioaccumulation | Freshwater Sediment | Bioaccumulation | CPEC? |
| Aluminum[2] | 8714 | - | - | - | - | **Yes** |
| Arsenic | 2.05 | 57 | 4 | 0.0360 | 0.51337 | No |
| Barium[2] | 44.23 | - | - | - | - | **Yes** |
| Cadmium | 4.50 | 5.1 | 0.003 | 0.8817 | 1498.9 | **Yes** |
| Chromium | 13.54 | 260 | 4200 | 0.0521 | 0.0032 | No |
| Cobalt[2] | 4.56 | - | - | - | - | **Yes** |
| Copper | 19.56 | 390 | 10 | 0.0502 | 1.96 | No |
| Iron[2] | 9603 | - | - | - | - | **Yes** |
| Lead | 48 | 450 | 128 | 0.1067 | 0.375 | No |
| Manganese[2] | 176 | - | - | - | - | **Yes** |
| Nickel | 10.5 | 46 | 316 | 0.2275 | 0.0331 | No |
| Silver[2] | 0.95 | 6.1 | - | 0.1557 | - | **Yes** |
| Vanadium[2] | 16.7 | - | - | - | - | **Yes** |
| Zinc | 345 | 410 | 3 | 0.8420 | 115.07 | **Yes** |

Notes:

1. Contaminants retained after preliminary screening (essential nutrient, detection frequency, and background concentration comparison).
2. These contaminants were retained as CPECs because of the lack of SLVs.
3. Risk ratios were calculated using the 95% UCL as the EPC.

CPEC = Contaminant of ecological concern
EPC = Exposure point concentration
SLV = Screening level value
UCL = Upper confidence limit
WDOE = Washington Department of Ecology
mg/kg = Milligram per kilogram

# Attachment B

# Ecological Scoping Checklist

**Ecological Scoping Checklist**

| | |
|---|---|
| Site Name | Longshot Mine |
| Date of Site Visit | June 21, 22, and 23, 2005 |
| Site Location | 11 miles northeast of Colville, Stevens County, Washington, Colville National Forest |
| Site Visit Conducted by | Matt Norberg |

Part ❶

| **CONTAMINANTS OF INTEREST**<br>**Types, Classes, Or Specific Hazardous Substances**<br>**Known Or Suspected** | **Onsite** | **Adjacent to or in locality of the facility** |
|---|---|---|
| Mining related activities-primarily metals | Yes | Yes |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Part ❷

| **OBSERVED IMPACTS ASSOCIATED WITH THE SITE** | **Finding** |
|---|---|
| Onsite vegetation (**N**one, **L**imited, **E**xtensive) | E |
| Vegetation in the locality of the site (**N**one, **L**imited, **E**xtensive) | E |
| Onsite wildlife such as macroinvertebrates, reptiles, amphibians, birds, mammals, other (**N**one, **L**imited, **E**xtensive) | E |
| Wildlife such as macroinvertebrates, reptiles, amphibians, birds, mammals, other in the locality of the site (**N**one, **L**imited, **E**xtensive) | E |
| Other readily observable impacts (**N**one, **D**iscuss below) | D |

Discussion:
Two open observable adits and one open stope are present at the site. Remnants of a mill and other wooden structures are present at the site. Numerous waste rock piles (6) are scattered across the site. Many of the waste rock piles are vegetated with trees and some grasses. One small settling pond and one large tailings pond are present on site with the settling pond receiving input from the adit discharge. There is also an unprocessed ore bin, and three tailings impoundments.

**Ecological Scoping Checklist (continued)**

Part ❸

| SPECIFIC EVALUATION OF ECOLOGICAL RECEPTORS / HABITAT | Finding |
|---|---|
| ***Terrestrial - Wooded*** | |
| Percentage of site that is wooded | 95% |
| Dominant vegetation type (**E**vergreen, **D**eciduous, **M**ixed) | E |
| Prominent tree size at breast height, i.e., four feet (<6”, 6” to 12”, >12”) | 6”-12” |
| Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther) | M, B, M |
| ***Terrestrial - Scrub/Shrub/Grasses*** | |
| Percentage of site that is scrub/shrub | <5% |
| Dominant vegetation type (**Sc**rub, **Sh**rub, **G**rasses, **O**ther) | Sh, G, O |
| Prominent height of vegetation (<2’, 2’ to 5’, >5’) | 2’ to 5’ |
| Density of vegetation (**D**ense, **P**atchy, **S**parse) | P |
| Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther) | M, B, M |
| ***Terrestrial - Ruderal*** | |
| Percentage of site that is ruderal | <5% |
| Dominant vegetation type (**L**andscaped, **A**griculture, **B**are ground) | B |
| Prominent height of vegetation (0’, >0’ to <2’, 2’ to 5’, >5’) | 0’ to <2’ |
| Density of vegetation (**D**ense, **P**atchy, **S**parse) | P |
| Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther) | B, M |
| ***Aquatic - Non-flowing (lentic)*** | |
| Percentage of site that is covered by lakes or ponds | <5% |
| Type of water bodies (**L**akes, **P**onds, **V**ernal pools, **I**mpoundments, **Lag**oon, **R**eservoir, **C**anal) | P |
| Size (acres), average depth (feet), trophic status of water bodies | <1, <5, M |
| Source water (**R**iver, **St**ream, **G**roundwater, **I**ndustrial discharge, **Su**rface water runoff) | St, G |
| Water discharge point (**N**one, **R**iver, **St**ream, **G**roundwater, **W**etlands impoundment) | S, W |
| Nature of bottom (**M**uddy, **R**ocky, **S**and, **C**oncrete, **O**ther) | M |
| Vegetation present (**S**ubmerged, **E**mergent, **F**loating) | S, E |
| Obvious wetlands present (**Y**es / **N**o) | Y |
| Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther) | M, A |
| ***Aquatic - Flowing (lotic)*** | |
| Percentage of site that is covered by rivers, streams (brooks, creeks), intermittent streams, dry wash, arroyo, ditches, or channel waterway | <1% |
| Type of water bodies (**R**ivers, **S**treams, **I**ntermittent Streams, **D**ry wash, **A**rroyo, **D**itches, **C**hannel waterway) | S, I |
| Size (acres), average depth (feet), approximate flow rate (cfs) of water bodies | <1, <6”, <1 |
| Bank environment (cover: **V**egetated, **B**are / slope: **S**teep, **G**radual / height (in feet)) | V/G |

**Ecological Scoping Checklist (continued)**

| SPECIFIC EVALUATION OF ECOLOGICAL RECEPTORS / HABITAT | Finding |
|---|---|
| Source water (**R**iver, **St**ream, **G**roundwater, **I**ndustrial discharge, **Su**rface water runoff) | St, G |
| Tidal influence (**Y**es / **N**o) | N |
| Water discharge point (**N**one, **R**iver, **St**ream, **G**roundwater, **W**etlands impoundment) | St |
| Nature of bottom (**M**uddy, **R**ocky, **S**and, **C**oncrete, **O**ther) | R, S |
| Vegetation present (**S**ubmerged, **E**mergent, **F**loating) | E |
| Obvious wetlands present (**Y**es / **N**o) | Y |
| Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther) | M, B, M |
| ***Aquatic - Wetlands*** | |
| Obvious or designated wetlands present (**Y**es / **N**o) | Y |
| Wetlands suspected as site is/has (**A**djacent to water body, in **F**loodplain, **S**tanding water, **D**ark wet soils, **M**ud cracks, **D**ebris line, **W**ater marks) | A, F |
| Vegetation present (**S**ubmerged, **E**mergent, **S**crub/shrub, **W**ooded) | E,S |
| Size (acres) and depth (feet) of suspected wetlands | <1, <1 |
| Source water (**R**iver, **St**ream, **G**roundwater, **I**ndustrial discharge, **Su**rface water runoff) | St, G |
| Water discharge point (**N**one, **R**iver, **St**ream, **G**roundwater, **I**mpoundment) | St, G, I |
| Tidal influence (**Y**es / **N**o) | N |
| Evidence / observation of wildlife (**M**acroinvertebrates, **R**eptiles, **A**mphibians, **B**irds, **M**ammals, **O**ther) | M |

Part ❹

| ECOLOGICALLY IMPORTANT SPECIES / HABITATS OBSERVED |
|---|
| None observed |

**Evaluation of Receptor-Pathway Interactions**

| EVALUATION OF RECEPTOR-PATHWAY INTERACTIONS | Y | N | U |
|---|---|---|---|
| **Are hazardous substances present or potentially present in surface waters?**<br>**AND**<br>**Are ecologically important species or habitats present?**<br>**AND**<br>**Could hazardous substances reach these receptors via surface water?** | X<br><br>X<br><br>X | | |
| When answering the above questions, consider the following:<br>• Known or suspected presence of hazardous substances in surface waters.<br>• Ability of hazardous substances to migrate to surface waters.<br>• Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters. Aquatic receptors may be exposed through osmotic exchange, respiration or ventilation of surface waters.<br>• Contaminants may be taken-up by terrestrial plants whose roots are in contact with surface waters.<br>• Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a drinking water source. | | | |
| **Are hazardous substances present or potentially present in groundwater?**<br>**AND**<br>**Are ecologically important species or habitats present?**<br>**AND**<br>**Could hazardous substances reach these receptors via groundwater?** | X<br><br>X<br><br>X | | |
| When answering the above questions, consider the following:<br>• Known or suspected presence of hazardous substances in groundwater.<br>• Ability of hazardous substances to migrate to groundwater.<br>• Potential for hazardous substances to migrate via groundwater and discharge into habitats and/or surface waters.<br>• Contaminants may be taken-up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1m depth).<br>• Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface. | | | |

**“Y” = yes; “N” = No, “U” = Unknown (counts as a “Y”)**

**Evaluation of Receptor-Pathway Interactions (continued)**

| EVALUATION OF RECEPTOR-PATHWAY INTERACTIONS | Y | N | U |
|---|---|---|---|
| **Are hazardous substances present or potentially present in sediments?**<br>**AND**<br>**Are ecologically important species or habitats present?**<br>**AND**<br>**Could hazardous substances reach these receptors via contact with sediments?** | X<br><br>X<br><br>X | | |
| When answering the above questions, consider the following:<br>• Known or suspected presence of hazardous substances in sediment.<br>• Ability of hazardous substances to leach or erode from surface soils and be carried into sediment via surface runoff.<br>• Potential for contaminated groundwater to upwell through, and deposit contaminants in, sediments.<br>• If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods. Aquatic receptors may be directly exposed to sediments or may be exposed through osmotic exchange, respiration or ventilation of sediment pore waters.<br>• Terrestrial plants may be exposed to sediment in an area that is only periodically inundated with water.<br>• If sediments are present in an area that is only periodically inundated with water, terrestrial species may have direct access to sediments for the purposes of incidental ingestion. Aquatic receptors may regularly or incidentally ingest sediment while foraging. | | | |
| **Are hazardous substances present or potentially present in prey or food items of ecologically important receptors?**<br>**AND**<br>**Are ecologically important species or habitats present?**<br>**AND**<br>**Could hazardous substances reach these receptors via consumption of food items?** | X<br><br><br>X<br><br>X | | |
| When answering the above questions, consider the following:<br>• Higher trophic level terrestrial and aquatic consumers and predators may be exposed through consumption of contaminated food sources.<br>• In general, organic contaminants with log $K_{ow} > 3.5$ may accumulate in terrestrial mammals and those with a log $K_{ow} > 5$ may accumulate in aquatic vertebrates. | | | |

**"Y" = yes; "N" = No, "U" = Unknown (counts as a "Y")**

**Evaluation of Receptor-Pathway Interactions (continued)**

| EVALUATION OF RECEPTOR-PATHWAY INTERACTIONS | Y | N | U |
|---|---|---|---|
| **Are hazardous substances present or potentially present in surficial soils?**<br>**AND**<br>**Are ecologically important species or habitats present?**<br>**AND**<br>**Could hazardous substances reach these receptors via incidental ingestion of or dermal contact with surficial soils?** | X<br><br>X<br><br><br>X | | |
| When answering the above questions, consider the following:<br>• Known or suspected presence of hazardous substances in surficial (~1m depth) soils.<br>• Ability of hazardous substances to migrate to surficial soils.<br>• Significant exposure via dermal contact would generally be limited to organic contaminants that are lipophilic and can cross epidermal barriers.<br>• Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash).<br>• Contaminants in bulk soil may partition into soil solution, making them available to roots.<br>• Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil or while grooming themselves clean of soil. | | | |
| **Are hazardous substances present or potentially present in soils?**<br>**AND**<br>**Are ecologically important species or habitats present?**<br>**AND**<br>**Could hazardous substances reach these receptors via vapors or fugitive dust carried in surface air or confined in burrows?** | X<br><br>X<br><br><br>X | | |
| When answering the above questions, consider the following:<br>• Volatility of the hazardous substance (volatile chemicals generally have Henry's Law constant > $10^{-5}$ atm-$m^3$/mol and molecular weight < 200 g/mol).<br>• Exposure via inhalation is most important to organisms that burrow in contaminated soils, given the limited amounts of air present to dilute vapors and an absence of air movement to disperse gases.<br>• Exposure via inhalation of fugitive dust is particularly applicable to ground-dwelling species that could be exposed to dust disturbed by their foraging or burrowing activities or by wind movement.<br>• Foliar uptake of organic vapors would be limited to those contaminants with relatively high vapor pressures.<br>• Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces. | | | |

**"Y" = yes; "N" = No, "U" = Unknown (counts as a "Y")**

# Attachment C

## List of Sensitive Plant and Animal Species in Colville National Forest

## Species of Concern
## Colville National Forest

### Endangered Species

| |
|---|
| *Rangifer tarandus caribou* (Woodland Caribou) |

### Threatened Species

| Animals | |
|---|---|
| *Haliaeetus leucocephalus* (Bald Eagle) | *Ursus arctos horribilis* (Grizzly Bear) |
| *Salvelinus confluentus* (Bull Trout) | *Lynx Canadenis* (Canada Lynx) |
| *Canis lupus* (Gray Wolf) | |
| **Plants** | |
| *Spiranthes diluvialis* (Ute Ladies'-tresses) | |

### Candidate Species

| | |
|---|---|
| *Rana luteiventris* (Columbia Spotted Frog) | *Botrychium lineare* (Slender Moonwort) |

### Sensitive Species

| Animals | |
|---|---|
| *Grus Canadensis* (Sandhill Crane) | *Corynorhinus townsendii* (Townsend's Big-eared Bat) |
| *Strix nebulosa* (Great Gray Owl) | *Gulo gulo* (Wolverine) |
| *Rana pipiens* (Northern Leopard Frog) | *Prosopium coulteri* (Pygmy Whitefish) |
| **Plants** | |
| *Scouleria marginata* | *Dermatocarpon luridum* |
| *Schistostega pennata* | *Peltigera pacifica* |
| *Leptogium burnetiae var. hirsutum* | *Leptogium cyanescens* |
| *Nephroma bellum* | *Peltigera neckeri* |
| *Tetraphis geniculata* | *Tholurna dissimilis* |
| *Carex dioica var. gynocrates* | *Carex comosa* |
| *Antennaria corymbosa* | *Antennaria parvifolia* |
| *Astragalus microcystis* | *Botrychium ascendens* |
| *Botrychium campestre* | *Botrychium crenulatum* |
| *Botrychium hesperium* | *Botrychium lineare* |
| *Botrychium pedunculosum* | *Botrychium paradoxum* |
| *Carex foenea* | *Carex capillaris* |
| *Carex hystericina* | *Carex flava* |
| *Carex xerantica* | *Carex rostrata* |
| *Cicuta bulbifera* | *Chrysosplenium tetrandrum* |
| *Cypripedium parviflorum* | *Cryptogramma stelleri* |
| *Dryopteris cristata* | *Dryas drummondii* |
| *Gaultheria hispidula* | *Eriophorum viridicarinatum* |
| *Hypericum majus* | *Geum rivale* |
| *Lycopodiella inundata* | *Lobelia kalmii* |

| Plants (continued) | |
|---|---|
| *Muhlenbergia glomerata* | *Lycopodium dendroideum* |
| *Physaria didymocarpa var. didymocarpa* | *Ophioglossum pusillum* |
| *Salix candida* | *Platanthera obtusata* |
| *Salix pseudomonticola* | *Salix maccalliana* |
| *Sanicula marilandica* | *Sisyrinchium septentrionale* |
| *Talinum sediforme* | *Spartina pectinata* |
| *Thalictrum dasycarpum* | *Teucrium canadense ssp. viscidum* |
| *Vaccinium myrtilloides* | |

**APPENDIX C**

**SITE PHOTOGRAPHS**

**Photo 1.  Lower adit**

**Photo 2.  Discharge from lower adit**

**Photo 3. Small settling pond (PD1)**

**Photo 4. Partially collapsed mill structure**

**Photo 5. Partially collapsed mill and ore bin**

**Photo 6. Mill foundation and ore bin**

**Photo 7. Unprocessed ore and wood debris**

**Photo 8. Waste rock pile across from lower adit and above mill (WR1)**

**Photo 9.  Waste rock pile adjacent to mill (WR2)**

**Photo 10. Waste rock pile along road to upper adit (WR3)**


**Photo 11. Upper adit**


**Photo 12. Waste rock piles (WR5 and WR6) along road to stope**


**Photo 13. Stope and vertical rock face**


**Photo 14. Tailings impoundment TA1**


**Photo 15. Tailings impoundment TA1**


**Photo 16. Tailings impoundment TA-1**


**Photo 17. Tailings impoundment TA2**


**Photo 18. Tailings impoundment TA2**


**Photo 19.  Tailings impoundment TA3**


**Photo 20.  Tailings impoundment TA3**

**Photo 21. Large pond (PD2) below TA3**

**Photo 22. Sample collection from large pond (PD2)**


**Photo 23. Surface water sample location (ET2) in the ephemeral tributary**


**Photo 24. Surface water sample location (ET3) in the ephemeral tributary**

**Photo 25. Surface water sample location (ET4) ephemeral tributary at County Road 4954**

**Photo 26. South Fork Mill Creek valley**

**Photo 27. South Fork Mill Creek looking upstream of confluence with ephemeral tributary from site**

**Photo 28. South Fork Mill Creek looking downstream of confluence with ephemeral tributary from the site**


**Photo 29.  Beaver Ponds in South Fork Mill Creek**